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VOL. CXVIII.—No. 3067.] *LONDON: FRIDAY, OCTOBER* 10, 1924. [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY FOREIGN POST 1s. 3½d.

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E. J. Davis, M.I.Mech.E., Gas Engines Inspected, Tested and Reported upon. Over 25 years' experience. Tel.: Maryland 1736 & 1737. Wire: "Rapidising London." —Great Eastern Road, Stratford, E. 15. 1794

Spencer-Hopwood & Kirke PATENT BOILERS. *See page* 73, *Oct.* 3. 1994 Sole Makers: SPENCER BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

The Glasgow Railway Engineering Company, GOVAN, GLASGOW. LTD., London Office—12, Victoria Street, S.W. MANUFACTURERS OF RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES. CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1948

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New Wire Ropes, Half price. LONDON ELECTRIC FIRM, Croydon. 2430

Chains & Anchors (OF ALL KINDS). FELLOWS BROS., LTD., CRADLEY HEATH, STAFFS. 9158

Tank Locomotives. Specification and Workmanship equal to Main Line Locomotives. R. & W. HAWTHORN, LESLIE & CO. LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 1864

Steel Screwed and Socketed PIPING. FOR IMMEDIATE DELIVERY.

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Bever, Dorling & Co., Ltd., BRADFORD. HIGH-CLASS ENGINES FOR ALL PURPOSES, also WINDING, HAULING, AIR COMPRESSING and PUMPING ENGINES. 1896

GOLD MEDAL-INVENTIONS EXHIBITION-AWARDED Duckham's Patent Suspended WEIGHING MACHINES—HAST FERRY ROAD ENGINEERING WORKS COMPANY, LTD. LONDON, E.—Hydraulic Cranes, Grain Elevators, &c. See illus. Advt. last week, page 15. 1715

CRANES. All Types. GEORGE RUSSELL & CO., LTD., Motherwell. 1667 Telegrams:—"Cylinders," Birmingham.

Weldless-Steel Tubes for Water-tube Boilers, Superheaters, Shafting, Hydraulic Work, Boring Rods, &c. TUBES LIMITED, BIRMINGHAM. 06179

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For Your Repairs or any SPECIAL MACHINERY, try THOMAS HUNT & SONS, Albion Ironworks. Bridge Road West, Battersea, S.W.11. Estd. 1854. 2348

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Dredging Plant— For ALLUVIAL GOLD, PLATINUM & TIN, HARBOUR, RIVER & CANAL.—Gravel Dredgers, SCREENS.—DREDGE BUCKETS & Parts, all sizes. ARTHUR R. BROWN, 54, New Broad Street, London, E.C.2. Telephone: London Wall 3418. 1814

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Iron and Steel Tubes and Fittings. Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 2257

The Scottish Tube Co., Ltd., HEAD OFFICE: 34, Robertson Street, Glasgow. See Advertisements pages 35 and 38.

Royles Limited, ENGINEERS, IRLAM, MANCHESTER. FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, STEAM and GAS KETTLES } Row's Patents. Merrill's Patent TWIN STRAINERS for Pump Suctions. SYPHONIA STEAM TRAPS, REDUCING VALVES High-class GUNMETAL STEAM FITTINGS. WATER SOFTENING and FILTERING. 5723

IRON & STEEL Tubes AND Fittings AND Steel Plates. STEWARTS AND LLOYDS, Ltd. GLASGOW - BIRMINGHAM - LONDON. See Advertisement, page 27. 1873

Cement—Maxted & Knott, Ltd., Consulting Cement Engineers, ADVISE GENERALLY on proposed Cement Schemes FOR ENGLAND AND ABROAD. ADVICE ONLY. Highest references. Established 1890. Address, BURNETT AVENUE, HULL. Cablegrams: "Energy, Hull." 1828

400 HP. Horizontal Cross Coupled Drop Valve Steam Engine, Cylinder 22½ in. diameter by 36 in. stroke, 80 lbs. w.p. 250 HP. Horizontal Cross Compound Drop Valve Steam Engine, by Marshall. 140 HP. Garrett Super Heater Steam Engine and Boiler with accessories. Horizontal Steam Engine, by Marshall, Cylinder 13 in. diameter by 37 in. stroke, 40 N.HP. Loco type Boiler, by Marshall, new 1915, 150 lbs. w.p. Babcock & Wilcox Land type Boiler, 40 tubes, new 1910, 160 lbs. w.p. 20 N.HP. Loco type Boiler, by Robey, new 1913, 120 lbs. w.p. Cornish Boiler 20 ft. by 6 ft., 100 lbs. w.p. HARRY H. GARDAM & CO., LIMITED, Staines. G 2

Regent Guillotine Shears and Power Presses FOR SHEET AND PLATE WORKING. THE REGENT SHEET METAL MACHINE TOOL CO., LTD., REGENT WORKS, WAKEFIELD. 2013

Very Fine 120 K.W.D.C. GENERATOR by L. D. & M. 420/480 volts, 150 revs., six poles and interpoles. Compound. 100 HP., A.C. MOTOR, by B. T. H., three phase, 50 cycles, 400/440 volts, 580 revs. Slip-ring induction motor. Totally enclosed, pipe ventilated. Ellison starting gear. New 12 HP. A.C. Motor, by Mather and Platt, three phase, 50 cycles, 440 volts, 960 revs. Pipe ventilated. Ellison starting gear. A large selection of Vertical Boilers in stock. From 5 ft. by 2 ft. 3 in. to 16 ft. 6 in. by 8 ft. Working pressures up to 150 lbs. New 6 in. 2-Stage Motor-Driven Centrifugal Pump, by Pulsometer. 500 gallons per minute, against 160 ft. head. Brass impellers. 40 HP. D.C. Motor, by Phœnix. 440/460 volts, four poles and interpoles. On C.I. bedplate. No. 9 Pulsometer. 41,000 gallons per hour, hinged lids. Two new 3 ft. 6 in. Radial Drilling Machines. Box bedplates. Rise and fall arms, 3½ in. spindles. Bored Morse taper. S.A. feeds, etc. THOMAS MITCHELL & SONS, LTD., Edgar Street, BOLTON. 2405 Telephone 302 (Three Lines). Telegrams: "Realize."

ON ADMIRALTY LIST. John Kirkaldy, Ltd., London Office: 101, LEADENHALL ST., E.C.3. Works: BURNT MILL, near HARLOW, ESSEX. Makers of Evaporating and Distilling Plants. Refrigerating and Ice-making Machinery. Feed Water Heaters. Evaporators. Fresh Water Distillers. Main Feed Pumps. Combined Circulating and Air Pumps. Auxiliary Surface Condensers, &c., &c. 3327

YARROW & CO. (1922), LTD., GLASGOW. LAND AND MARINE YARROW BOILERS. 2277

John Bellamy Limited MILLWALL, LONDON, E. GENERAL CONSTRUCTIONAL ENGINEERS. 1216 Boilers, Tanks & Mooring Buoys STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETTED STEAM and VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

Head, Wrightson & Co., LIMITED. See Advertisement page 32, Oct. 3. 2402

PROPELLERS AND PROPULSION PROBLEMS. Special designs only. "Circulation Theory." Akimoff Propeller Company, PHILADELPHIA, U.S.A. 2349

Diesel Engines, 300, 530, 800, 1200 and 1750 B.HP., M.A.N., with or without dynamos; condition as new. About one-third market price; seen London. For all spares above sizes in stock. HICK DIESEL OIL ENGINES, LTD., 70, Queen Street, E.C. 4. 2043

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Yorkshire Engine Co., Ltd., Meadow Hall Works, Sheffield, Railway, Colliery, Mining and General Engineers, are PREPARED to UNDERTAKE the MANUFACTURE of NEW SPECIALITIES suited to their plant and tools. No financing of patents. Only serious business entertained. Address confidential enquiries to the SECRETARY. 2404

Petter Oil Engines. For Paraffin and Crude Oil Sizes 1½ B.HP. and upwards. Petters Limited, Yeovil. Sizes 25 to 500 B.HP. Vickers-Petters, Ltd., Ipswich See advertisement alternate weeks. 9235

P. & W. MacLellan, Ltd., CLUTHA WORKS, GLASGOW. MANUFACTURERS OF RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION. RAILWAY IRONWORK, BRIDGES, ROOFING, &c. Chief Offices: 120, Trongate, Glasgow. Od 3547 Registered Offices: Clutha House, 10, Princes St., Westminster, S.W.1.

The Manchester Steam Users' Association.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, Mount Street, Manchester.

Chief Engineer: C. B. Stromeyer, M.I.C.E.

Founded 1854 by Sir William Fairbairn.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 2005

Correspondence Courses for Inst. Civil Engrs., Inst. Mech. E., London Univ. (Matric., Inter., B.Sc.). Inst. M. & Cy. E., and ALL ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours) Eng. London, Assoc. M. Inst. C.E., Chartered Civil Engineer, M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of successful Students. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, Trafford Chambers, 58, South John Street, Liverpool.

Engineering Salesmanship and SALES MANAGEMENT.—Write for brochure describing our special Course of Training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 333, Oxford Road, Manchester. 2289

Engineering Drawing.—Special Postal Course in Engineering Drafting. Enrol now. Fee Three Guineas for the complete course. Also day tuition in Office by qualified teacher. Established in 1895.—PERCY PITMAN, M.I.Mech.E., 23, Victoria Street, London, S.W.1. 2297

Structural Engineering.—A Civil Engineer gives a Course of Instruction by Correspondence in the calculation of stresses in Beams, Columns and Trusses.—Address, G 70, Offices of Engineering.

TENDERS.

The Director-General, India Store Department, Branch No. 16, Belvedere Road, Lambeth, S.E.1, REQUIRES:—

STEEL FISHBOLTS and NUTS.

Tenders due on the 24th October, 1924.

Tender forms obtainable from above. G 83

READING (WITHIN EASY DISTANCE), ON MAIN SOUTH ROAD.

To be Sold by Tender, Free-HOLD STOCK-IN-TRADE and PLANT of a General Engineer and Motor Repairer. Full particulars of the Property, together with Schedule of the Stock-in-Trade, Machinery and Plant, to be obtained from the sole Agents, AYRES AND RICHARDS, F.A.I., Auctioneers and Valuers, 21 & 22, Market Place, Reading. G 46

BOMBAY, BARODA AND CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Friday, 24th October,

Tenders for the Supply of:—

PAINTS, etc.

Tenders must be made on forms, copies of which with Specification, can be obtained at these Offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: 91, Petty France, Westminster, S.W.1.
8th October, 1924. G 81

BENGAL-NAGPUR RAILWAY COMPANY LIMITED.

The Directors are prepared to receive

Tenders for:—

3600 VOLUTE SPRINGS.

Specification and Form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad Street, E.C.2, on or after 6th October, 1924.

A fee of 20s. will be charged for the Specification, which is NOT returnable.

Tenders must be submitted not later than NOON on Thursday, 16th October, 1924.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. WOLKERS,
Secretary. G 61

CITY OF BIRMINGHAM ELECTRIC SUPPLY DEPARTMENT.

A.C. Generating Plant for SALE.

The Undermentioned PLANT, installed at the Corporation Electric Generating Station, Summer Lane, Birmingham, is FOR DISPOSAL:—

One Belliss Triple-expansion, Three-cylinder ENGINE, direct coupled to 1500 K.V.A. Three-phase Alternator, 5000 volts, 25 periods, 166 r.p.m., by Dick Kerr & Co., Ltd. (combined as one unit), with Belliss EXHAUST STEAM TURBINE, direct coupled to a Westinghouse 1500 K.V.A. Three-phase Alternator, 1500 r.p.m., complete with Condenser. Motor-driven Edwards' Air Pumps, Interconnecting Piping, Ladders and Gangways.

The Plant, which will be released in January, 1925, was installed in 1912, is in first-class condition and can be inspected or seen on load by appointment.

The dismantling and removal of the plant to be carried out by the purchaser at his own expense and risk.

The use of an overhead travelling crane will be allowed free, the purchaser to accept all responsibility for any damage done to buildings or other plant in the Station.

Fuller particulars and permits to inspect can be obtained on application to the undersigned, to whom all offers should be addressed.

Offers should be sent in not later than 13th October, 1924.

E. J. JENNINGS,
Secretary.

14, Dale End,
Birmingham.
September, 1924. G 19

THE SOUTH INDIAN RAILWAY COMPANY LIMITED,
are prepared to receive

Tenders for the Supply of:—

1. STEEL RAILS and FISHPLATES.
2. CAST IRON PIPES.
3. PORTLAND CEMENT.
4. WAGONS.

Specifications and Forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W.1.

Tenders addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked:—"Tender for Steel Rails and Fishplates," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 24th October, 1924, for Specifications Nos. 1, 2, and 3, and on Friday, the 12th December, 1924, for Specification No. 4.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5/- for each copy of Specifications Nos. 1, 2, and 3, and of £1 for each copy of Specification No. 4.

Copies of the Drawings may be obtained at the Offices of the Company's Consulting Engineers, Messrs. Robert White & Partners, of 3, Victoria Street, Westminster, S.W.1.

A. MUIRHEAD.
Managing Director.

91, Petty France, S.W.1.
7th October, 1924 G 82

ABERDEEN CORPORATION WATER WORKS.

TORRY MAIN—CAST IRON PIPES AND PIPE LAYING.

The Town Council of Aberdeen are prepared to receive

Tenders for:—

(1) The SUPPLY of half a mile of 9 inch diameter Cement-lined CAST IRON PIPES and SPECIALS.

(2) The LAYING of the above PIPES.

The Drawings may be inspected, and Specification, Schedule of Quantities, and Form of Tender obtained on and after 2nd October, 1924.

For each Specification a deposit of Two Pounds Sterling will be required, which sum will be returned to the Tenderer provided that he shall have sent in a *bona fide* Tender, and shall not have withdrawn the same.

The employment of labour shall be in accordance with the conditions of the Unemployment Grants Committee.

Tenders, on the Forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for PIPING," are to be addressed to the Undersigned. No Tender delivered after Nine a.m. on 16th October, 1924, will be considered.

The Town Council do not bind themselves to accept the lowest or any Tender.

GEORGE MITCHELL,
M.Inst.C.E., F.R.San.I.,
Water Engineer.

Water Engineer's Office,
41½, Union Street, Aberdeen.
30th September, 1924. G 30

BOMBAY, BARODA & CENTRAL INDIA RAILWAY COMPANY.

ELECTRIFICATION OF BOMBAY SUBURBAN LINES.

The Directors are prepared to receive

Tenders for the Supply of the following PLANT, namely:—

1. ELECTRICAL EQUIPMENT OF COACHES.

Fee for Specifications, £2 per copy.

Specifications and Forms of Tender (which must be submitted in duplicate) may be obtained at this Office on or after October 13th, 1924, on payment of the fee for Specification, which payment will not be returned.

Tenders must be sealed and addressed to the undersigned, marked "Tender for Electrical Equipment of Coaches," and delivered not later than Noon on Monday, December 15th, 1924.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Bombay, Baroda and Central India Railway Company.

The Directors do not bind themselves to accept the lowest or any Tender.

The Consulting Engineers, to whom application for any further technical information may be made, are Messrs. Merz & McLellan, 32, Victoria Street, Westminster, S.W.1.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion, 91, Petty France, Westminster, S.W.1.
3rd October, 1924. G 59

THE MUNICIPALITY OF SINGAPORE.
TENDERS FOR STEEL PIPES, VALVES, &c.

Sealed Tenders, Addressed to Messrs. C. C. Lindsay & Peirce, 180, Hope Street, Glasgow (Agents to the Municipality of Singapore) endorsed "Singapore Municipality—Tender for Steel Pipes, Valves, etc.," will be received until Five p.m. on Friday, the 31st October, 1924, for the SUPPLY and DELIVERY at Singapore of about SIX MILES of WELDED STEEL PIPE, 33 inches internal diameter; about SIX MILES of WELDED STEEL PIPE 36 inches internal diameter; about SIX MILES of WELDED STEEL PIPE 39 inches internal diameter, together with certain CAST IRON PIPES, VALVES, and SPECIALS. Though Lap-Welded Steel Pipes are specified, Tenderers are at liberty to offer other makes of steel pipes, but riveted pipes will not be accepted, and whatever make of pipe may be offered must be of British Material and manufacture. Forms of Tender and Specification may be obtained on and after the 10th October, 1924, from Sir Alex. Binnie Son and Deacon, 30, Buckingham Gate, Westminster, S.W.1, or from the Agents to the Municipality, on receipt by either of them of a cheque to the value of £5, made out to the Agents, Messrs. C. C. Lindsay and Peirce, which amount will be returned on receipt of a *bona fide* Tender. Drawings may be seen at the offices of Messrs. Sir Alex. Binnie Son and Deacon. The lowest or any Tender will not necessarily be accepted nor will any expenses in connection with Tendering be defrayed. No Tenders will be considered except from actual manufacturers, capable of supplying the pipes at the rate of 90 of each size per fortnight, together with a proportionate number of specials.

C. C. LINDSAY & PEIRCE,
180, Hope Street, Glasgow.
(Agents to the Municipal Commissioners of Singapore). G 65

THE GREAT INDIAN PENINSULA RAILWAY COMPANY of 48, COPTHALL AVENUE, LONDON, E.C.2, invite

Tenders for:—

1.	Mild Steel Bars, Sections, etc. ...	...Fee 10/-
2.	Drysalteries, etc.	... ,, 7/6
3.	Steel Spikes, Pins and Washers ...	... ,, 2/6
4.	Points and Crossings, etc.	... ,, 2/6
5.	Bright Drawn Mild Steel Bars (for use in automatic lathes)	... ,, 2/6
6.	Linoleum	... ,, 7/6
7.	Carriage Door Handles, Hinges, etc. ...	,, 2/6
8.	Rolled Steel Disc Wheels and Axles for C & W.	... ,, 10/-

Tenders are due by Eleven a.m. on 21st October, 1924. Tender Forms obtainable at above address. Fees not returnable. G 89

WICK HARBOUR.

WEIGHBRIDGE FOR SALE.

The Steel Weighbridge, by H. Pooley & Sons (which weighs up to Five Tons), on the North Pier of the Harbour, and is being replaced by a larger machine, is FOR SALE by Private Bargain. Full particulars may be obtained from the subscriber, with whom offers, marked "Offer for Weighbridge," must be lodged not later than 31st inst.

W. E. WOOKEY,
Harbour Engineer.

Wick,
1st October, 1924. G 52

APPOINTMENTS OPEN.

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY
(Faculty of Technology in the University of Manchester).

APPLICATION for APPOINTMENT as ASSISTANT LECTURER IN ELECTRICAL ENGINEERING.

The Governing Body invites

Applications for an Assistant LECTURESHIP in Electrical Engineering in the College of Technology.

Salary: £300 per annum.

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester. The last day for the receipt of applications is Wednesday, 22nd October, 1924.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

E. MOUAZ JONES,
Principal of the College. G 47

Two Research Assistants (Senior and Junior) WANTED to carry out a Research upon blast furnace reactions at the Imperial College of Science and Technology, London, under the direction of Professor W. A. BONE, F.R.S., on behalf of the National Federation of Iron and Steel Manufacturers. A good knowledge of Physical Chemistry and Gas Analysis and manipulation essential. Salaries from £240 to £360 per annum according to qualifications.—Applications, with recent testimonials, should reach the DIRECTOR OF THE FEDERATION, Caxton House, Tothill Street, S.W.1, on or before Wednesday, October 22nd next. G 78

Wanted, Metallurgical CHEMIST for Brass and Copper Alloys. Preference given to one with practical knowledge of Smelting and Casting.—Apply by letter in first instance, stating qualifications and previous experience (in confidence), age, and wages required to HATTERSLEY (Ormskirk) LIMITED, Ormskirk, Lancashire. G 60

Experienced Sales Repre-SENTATIVE REQUIRED by leading firm in Lift Trade. Sound Engineering and Commercial training essential.—Address, in first instance, giving full details of qualifications, experience, age, and salary, G 37, Offices of Engineering.

Production Manager Wanted for well-equipped Works, London district, engaged upon varied high-quality work, including aero and other internal-combustion engines. Must be proved organiser, with technical and thorough practical training.

Applicants should write, stating age, pre- and post-war experience, including details of responsible positions already held, and salary expected, with references.—Address, G 58, Offices of Engineering.

The Royal Air Force REQUIRES ENGINE DRIVER FITTERS, POWER STATION ENGINEERS and WIRELESS OPERATORS. Age limits:—18 to 30. Pay from 24s. 6d. to 38s. 6d. per week, on enlistment, and all found. Allowance for wife and children to men 26 and over.—Write, stating age, or call:—INSPECTOR OF RECRUITING, R.A.F., 4, Henrietta Street, Covent Garden, W.C.2. F 993

Civil Engineering Assistant.—A Firm of Consulting Engineers REQUIRES at once, a Competent ENGINEERING ASSISTANT, with a large experience in the design and execution of Modern Sewerage and Sewage Disposal, and Water Supply Works.—Replies (which will be treated in confidence), giving experience, salary required, age, etc., to be addressed, G 17, Offices of Engineering.

Assistant Engineer REQUIRED by the GOVERNMENT of HONG KONG for service in the PUBLIC WORKS DEPARTMENT for a period of three years with possible permanency. Salary £460, rising to £600 a year by annual increments of £30, and thence, if appointment is made permanent, to £660 a year. The salary is converted into dollars at the Government rate of exchange, at present fixed at two shillings to the dollar, plus a temporary exchange allowance of 20 per cent. Conveyance allowance of $240 per annum is paid. Free passages provided. Candidates, unmarried, 24 to 30 years of age, must be fully qualified civil engineers with experience of drainage and sewer work and be conversant with modern sanitary appliances.—Apply at once, by letter, stating age and giving brief details of qualifications and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting clearly at head of application M/13168. G 54

Wanted, Foundry Organiser for Eastern Counties, capable of getting the best out of Foundry Moulding Machines. Send experience.—Address, G 43, Offices of Engineering.

Agriculture Department SUDAN GOVERNMENT, REQUIRES the SERVICES of a DIESEL ENGINE ENGINEER. Starting rate of pay, £E 300 to £E 360, according to age and qualifications. Progressive post. Candidates must be thoroughly experienced in Diesel engine construction and have good technical knowledge. Age 26 to 32 (single).—Apply, by letter, to CONSULTING MECH. ENGINEER, Sudan Government, Railways and Steamers, Wellington House, Buckingham Gate, S.W.1. G 45

Assistant Engineers. TWO REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT, for two tours of not less than 12 nor more than 18 months' service with possible extension. Salary £480 a year for first three years of service, then £510 rising to £720 a year by annual increments of £30 and thereafter to £920 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 35, preferably unmarried, must have had good general education and be A.M.I.C.E or hold equivalent qualifications. They must have had proper technical training and have had not less than two years subsequent experience on large Engineering or Municipal Works. Preference given to candidates with experience of Waterworks construction.—Apply at once by letter, stating age, qualifications and experience, also whether married or single, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting reference M/12963. G 66

Assistant Locomotive SUPERINTENDENT REQUIRED for the NIGERIAN GOVERNMENT RAILWAY for two tours of from 12 to 18 months' service, with prospect of permanency. Salary £480 a year for the first three years, then £510, rising by annual increments of £30, to £720, and thence, by annual increments of £40, to £920. Outfit allowance of £60 on first appointment. Free quarters and first-class passages and liberal leave on full salary. Candidates age 25 to 35, should be of good education and preferably possess an approved Engineering Diploma. They should have had a thorough training in the workshops of a British Railway or well-known Locomotive firm, should be conversant with the repair and erection of locomotives, carriages and wagons, and be well up in drawing-office work and have had running experience. Preference will be given to applicants who have acted in a supervising capacity.—Apply at once, by letter, stating age and particulars of qualifications and experience to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting M/Nig.13159. G 57

Draughtsman Required for General Engineering Works, but with special experience in Dyeing and Cleaning Machinery, for Engineering Works near Glasgow. State experience and salary required.—Address, G 48, Offices of Engineering.

Draughtsman Wanted; Civil Engineer with experience in design of large sewers and general construction work. Salary according to qualifications. Maximum about £8 a week.—Apply, CHIEF ENGINEER, London County Council, the Old County Hall, Spring Gardens, S.W.1. G 49

Wanted, Experienced Crane DRAUGHTSMAN. State age, qualifications and salary required.—Apply, RANSOMES AND RAPIER, Ltd., Waterside Works, Ipswich. G 80

Draughtsman, Well up in modern cranes and lifting appliances. Must be able to make own calculations and take responsibility.—Address, stating age, experience and wages, G 63, Offices of Engineering.

First-class Jig and Tool DRAUGHTSMAN WANTED, temporarily, by engineering firm in South Midlands, with experience in Press Tool and small repetition work.—Address, stating experience and salary required, G 64, Offices of Engineering.

Leading Draughtsman REQUIRED in Midlands. Must have wide experience in design of Hydraulic Machinery and Lifting Tackle. Good opening for energetic man.—Address, stating age, experience and salary required, G 66, Offices of Engineering.

Draughtsmen (Two), Mechanical, WANTED for Straight Settlements. Age 24-28. Must have good experience in general engineering and in estimating. Salary £33 per month, rising £3 per month each year. Five years' agreement Second-class passage out and home. Single men essential. Send fullest details, experience, and copies of references.—Address, DRAUGHTSMEN, Wm. Porteous & Co., Advertising Agents, Glasgow. G 79

Senior Draughtsman; Must be experienced in design of Commercial Vehicle Chassis components, and technical calculations connected therewith, accurate and reliable.—Age, experience and salary to DENNIS BROS., Ltd., Guildford. G 84

SITUATIONS WANTED.

Surveyor, with Considerable Experience abroad in surveying, including base line measurement, triangulation and precise levelling. Fair structural Draughtsman. Arabic and Hindustani.—Address, G 53, Offices of Engineering.

Mechanic, 28, Desires Change with view to improvement; three years' machine shop experience, ten years' toolroom, including three years' as charge-hand. Used to modern jig and toolmaking methods. Holds technical certificate for mathematics and machine drawing. Highest references.—Address, G 68, Offices of Engineering.

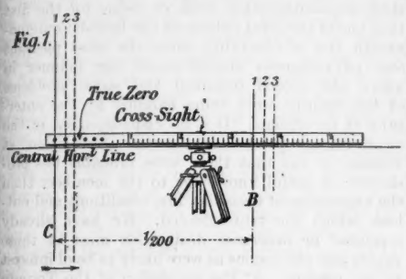
HORIZONTAL TACHEOMETRY.

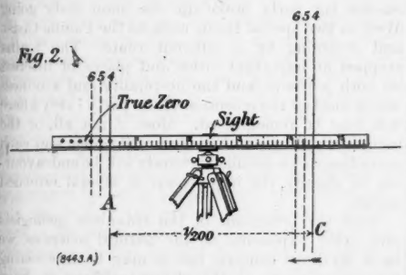
By C. H. LEY, Director of Surveys, Palestine.

Method.—It would perhaps be impertinent of me to suggest that in tacheometry experiment has not marched in the van of practice, but that there are directions in which its more extended use may be possible will perhaps appear from some experiments carried out in Palestine which are described below.

This description will refer to the taking of readings for range on a tacheometric staff of two stadia lines at a fixed distance apart in the diaphragm of a tacheometer; also to a method invented by Prof. Oltay of Buda-Pesth, by which the reading of a single central line in the diaphragm can be shifted through the necessary optical interval by means of a prism hinged in front of the object-glass of the instrument.

The troublesome inherent errors of tacheometry as normally carried out are well known, and I





would only say here that, in my own experience, one of the commonest sources of error in practice is differential parallax between the two stadia-lines, liability to which is eliminated by using the one-line method with the Oltay prism.

But the most deadly, because the most elusive, source of error in determinations of range by readings on a vertical staff is, of course, atmospheric refraction, by which the rays of light passing through the two lines in the diaphragm from the distant staff are unequally bent owing to a vertical temperature gradient in the lowest stratum of air. This temperature gradient is subject to continual change according to the thermal conditions of the moment or locality, and in hot countries its effect is often enormous, so that, even with very tall staves and short ranges, accurate results are unattainable.

Yet in certain parts of this country great advantage would result if ranges of say, from 50 to 250 metres could be accurately and quickly observed by tacheometry, especially in traverse work, and I therefore determined to make a thorough trial of horizontal tacheometry, in which the stadia lines are ruled across the central horizontal line of the diaphragm and the readings are made on a horizontal staff.

The Horizontal Staff.—After some trials, the pattern of staff illustrated in Figs. 1 and 2 was arrived at. This short and light staff was fitted with a central cross-sight and could be slid into a bracket carried by a ball in a socket mounted on a light tripod, so that it could be rapidly adjusted by eye in a horizontal position at right angles to any line of sight.

To facilitate readings in the heat-shimmer, which usually begins one or two hours after sunrise, I adopted a system of open graduations in which readings were to be to decimal points or half-decimal points of a division on the staff by estimation. Now one reading is obviously unreliable for such work, and, at the same time, if a series of readings is taken each reading of the series should be quite independent. Also it is most desirable so to camouflage the system that the congenial art of fudging becomes difficult and not worth practising by the young surveyor.

I therefore adopted a system of bulls-eyes at one end of the staff which were painted at varying distances from and around the true, but unmarked, zero-point of the staff graduations, which distances were so arranged that they would always provide readings to different decimal points—the shortages and excesses of which would cancel out in their summation. Thus, in the case of the six-bull staff used at Acre, the distances of the bulls-eyes in order from the true zero-point of the staff-graduations were :—

$$-15{\cdot}5,\ -8{\cdot}5,\ -3{\cdot}5,\ +4{\cdot}5,\ +9{\cdot}0,\ +14.0 \text{ cm.}$$

which gave readings, for instance, such as the following :—

$$35{\cdot}1 + 37{\cdot}4 + 39{\cdot}2 + 41{\cdot}8 + 43{\cdot}3 + 44{\cdot}9 = 241{\cdot}7 \text{ m.}$$

Readings.—Again, in order to obtain the great advantage for transport and handling of short staves even at long ranges, it was desirable to use each 1/200 stadia-interval an equal number of times, so that in summation the result would be equivalent to a number of 1/100 observations. As the stadia-lines are never exactly equidistant from the central cross-line, readings 2 and 3 of the above can be deduced from 1, and readings 5 and 6 from 4, but 4 cannot be deduced from 3 from a knowledge of the staff constants only.

Now I found, and I think it may be a matter of general experience, that in bringing a line up to bisection of a bulls-eye in one direction with the slow-motion screw there is a tendency to consistent shorts or overs, a matter partly personal. The bulls were not therefore bisected in continuous order from the outer bull, but the 3 outer bulls were bisected in one direction of motion and the three inner ones in the contrary direction, working inwards toward the zero-point in each set.

In Figs. 1 and 2, C is the central vertical line, and, on either side of it, A and B the stadia lines of the diaphragm of the telescope. In the first set the readings of B are taken on bisections with C of the three outer bulls in order from left to right. In the second set, the readings of C are taken on bisections with A of the three inner bulls in order from right to left.

The six readings are entered under one another in a column in the field book, and totalled to give the range. As a check the differences are also got out, and should agree with the known constants within a decimal point. This avoids all possibility of a gross error, and provides a ready means of analysis in case of doubtful work.

I found no difficulty in taking the six readings and applying the check in three minutes, and no doubt with practice this speed would be greatly improved upon. With the four-bull staff subsequently used a range should be observed and checked in the field in less than two minutes.

Staff Graduations.—It will be noted that the staff is so graduated that the sum of the readings is the true range, thus avoiding the necessity for obtaining a mean by division and removing an unnecessary source of arithmetical error. Now this involves a simple calculation for determining the actual distance between graduations on the staff. If R is the range, r a single reading, d the actual distance of r along the staff from the zero point of the graduations, n the number of bulls-eyes and readings, S the stadia-angle interval, and x the distance on the staff representing one metre of range, we have

$$d/S = R,\ r = R/n, \text{ and } x = d/r = n\,S.$$

Therefore if $S = \frac{1}{200}$, a 6-bull staff must be graduated with lines 6/200 m. = 3 cm. apart, reading successive metres, and a 4-bull staff would have graduations 2 cm. apart reading metres.

The choice of the number of bulls-eyes on such a staff thus in reality depends upon the maximum range likely to be wanted and the telescopic power of the instrument, and I came to the conclusion that the most useful combination is an instrument having a 30-power telescope and a 4-bull staff reading metres, the actual length of which would be about 175 cm. so as to cover ranges up to 300 metres.

Accuracy of Method.—Now consider the probable error of a complete observation of six readings under this system, assuming perfectly accurate graduation of staves and negligible error in bisection of bulls-eyes in comparison with the error of estimation of readings under fair conditions of atmosphere. Take a range of 200 metres at which we can estimate to the nearest decimal point with confidence. Our error of estimation should not exceed one half of this, *i.e.*, 0·05 of a division on the staff, and we may estimate the mean error at one half of this again, or 0·025 of a division. At 200 m., the reading will be 200/6, hence the mean error will be 0·025 in 200/6, or, put as a fraction, 1/1333. But there are six such readings independent of one another, and which, added together, make the total range-reading.

Hence, since the errors are of either sign, and accidental, the representative error of their sum will be the above fraction divided by $\sqrt{6}$, or 1/3300 nearly.

It might be thought that such a representative error must vary inversely as the range since the actual error would be constant. That is far from being the case, since the accuracy of estimation increases as we decrease the range, at least over the medium ranges. I came to the conclusion that accuracy had a maximum in the neighbourhood of 100 m., and that at less than 50 or over 250 m. the errors became excessive for purposes of very accurate traverse. It will be seen that the probable errors deduced from the inter-correspondence of the various observations on the same ranges are, for the most part, less than the above theoretical value.

Fig.3. ACRE PLAIN. AUG. 1922. 242·9 M. CLOUDLESS.

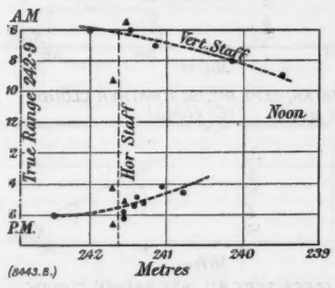


Fig.4. ACRE PLAIN. AUG. 1922. 182·9 M. CLOUDLESS.

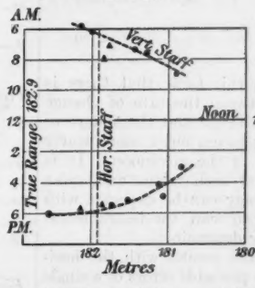
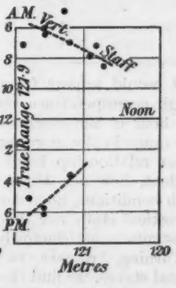


Fig.5. ACRE PLAIN. AUG. 1922. 121·9 M. CLOUDLESS.



EXPERIMENTS.

Observations at Acre.—The first series of experiments was carried out on a base-line on the Acre Plain in the hot weather of August, 1922, with a 5-in. Watts tacheometer, using two 2-m. staves, one mounted horizontally as described above, and one erected vertically. Observations on three ranges were taken over several hours after sunrise and before sunset on five different days in the same type of weather, approximately one observation being taken per hour. The resulting determinations were plotted on diagrams for each range against the time from noon, regardless of dates, the ordinates representing the time and the abscissæ the observed ranges on an open scale. In these diagrams (Figs. 3, 4 and 5) each vertical observation

is marked by a black circle and each horizontal observation by a small triangle.

Inspection of these diagrams shows that whereas in the case of the vertical staff large systematic variations of the range with time commence soon after sunrise and continue in the afternoon until sunset, changing in sign in the middle of the day, in the case of the horizontal staff there is no evidence whatever of any changes other than those which can be attributed to small ordinary accidental errors of reading. Drawing in the mean lines through the plotted points for the vertical staff, we obtain range-curves, the critical points of change of sign of which occur between 11 a.m. and 1 p.m., about the time of minimum refraction. The means for the horizontal staff are practically parallel to the ordinates. It was disappointing that owing to extreme heat and air-shimmer between 10 a.m. and 3 p.m., reliable observation became impossible, so that the change that took place in the middle of the day could not be traced. But the regularity of the results obtained on different days is testimony to the extraordinary regularity of the atmospheric conditions in normal summer weather in this country.

Tabulating the rate of change of the vertical observations at each range we obtain :—

Table I.—*Vertical Staff, Acre*, 1922.

Range m.	No. of Observations.	Time.	Variation per hour.
			m.
243	5	6–9 a.m.	−0·83
	8	4–6 p.m.	+0·45
183	5	6–9 a.m.	−0·40
	6	4–6 p.m.	+0·30
122	8	6–8.30 a.m.	−0·25
	4	3.30–5.30 p.m.	+0·20

It would appear from this table that there is rough correspondence between the rate of change per hour of the observed range and the square of the range in the morning hours, but a more nearly linear relationship holds in the afternoon. It is evident, however, that, at such ranges and under such conditions, no accuracy can be expected with a vertical staff, nor indeed can the instrumental constants be satisfactorily determined.

Turning, however, to the results with the horizontal staves, we find the probable errors of a single observation independent of time or occasion to be as follows :—

Table II.—*Horizontal Staff, Acre*, 1922.

Range.	No. of Observations.	P.E. Single Observation.	Remarks.
m.		m.	
243	5	0·054 or 1/4500	
183	5	0·089 ,, 1/2050	One wide observation.

If the wide observation at 183 m. were omitted, the probable error works out at 1/5300. Observations at 122 m. were not recorded, no variations being obtained on the first day.

Observations at Jaffa.—The second set of experiments was carried out near Jaffa on three different days in August and September, 1923, in somewhat cooler, but more variable, conditions.

A 6-in. Süss-Nandor tacheometer having a 35-power telescope was used, with a 4-bull staff having graduations 2 cm. apart, for the horizontal readings, and the vertical readings were obtained with the Oltay prism-attachment on an ordinary 3-m. levelling staff.

On August 19, a range was used in which, owing to a rise of ground, the lower ray with the prism passed only ½ m. above the surface at 120 m. from the instrument, and both rays from the horizontal staff passed at less than 1 m. above the ground at this spot. In the September observations, a more level range was obtained, and the sun was periodically obscured by light cloud.

Figs. 6 to 9 show the results plotted as before.

These observations were confined to the morning hours, but the actual ranges were not taped with sufficient accuracy properly to determine the instrumental constants. The results for the variation of range per hour on the vertical staff, are given on Table III annexed.

Table III.—*Vertical Staff, by Oltay Prism, Jaffa*, 1923.

Range.	No. of Observations.	Time.	Variation per hour.	Date.
m.			m.	
214	3	6.15–8.15 a.m.	−0·70	Aug. 19.
206	4	6–9 a.m.	−0·30	Sept. 2.
207	5	6.20–10.5 a.m.	−0·52	Sept. 9.
122	4	6.0–9.50 a.m.	−0·05	Sept. 9.

The irregularity of these figures is due in part to changes of actual site, and in part to more variable conditions. They appear to show the considerable improvement effected by using a longer vertical staff, especially at the shortest range; but, also show the unreliability of the method in ordinary varying conditions of ground and atmosphere. The effect of cloud on September 9 is noticeable in Figs. 8 and 9. But the results for

Fig. 6. JAFFA, AUG. 19TH, 1923. CLOUDLESS.

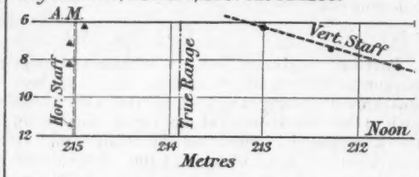


Fig. 7. JAFFA, SEPT. 2ND, 1923. CLOUDLESS. COOL BREEZE.

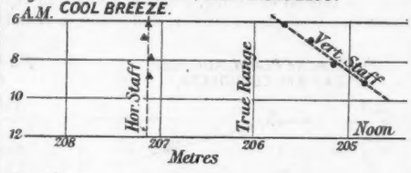


Fig. 8. JAFFA, SEPT. 9TH, 1923. RATHER CLOUDY. (C = Cloud)

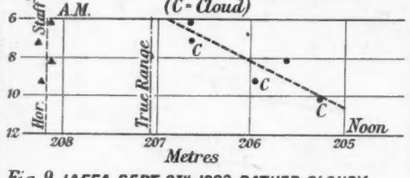
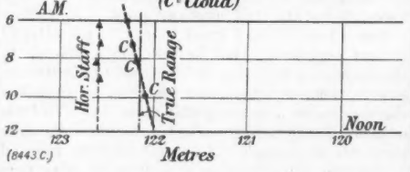


Fig. 9. JAFFA, SEPT. 9TH, 1923. RATHER CLOUDY. (C = Cloud)



(8443 C.)

the horizontal staff are again consistent, and remarkably accurate. The probable errors of a single observation work out at follows :—

Table IV.—*Horizontal Staff, Jaffa*, 1923.

Range.	No. of Observations.	P.E. Single Observations.	Remarks.
		m.	
214	3	0·060 or 1/3566	Hot.
206	4	0·024 ,, 1/8583	Cool breeze.
207	4	0·033 ,, 1/6300	Cloudy.
122	4	0·012 ,, 1/10166	Cloudy.

It is evident from this table that a gain in accuracy had been effected by using a more powerful telescope and a staff with somewhat closer divisions, in spite of the fact that the number of bulls-eyes and readings had been reduced from 6 to 4.

Conclusion.—It must be admitted that the horizontal method has still to stand the test of use in less open ground than was available in these experiments, and that it is probable that where the horizontal rays pass alongside a heated wall or bank, or other vertical object which is likely to produce a temperature-gradient in a horizontal direction, there exists the liability to horizontal distortion of the rays which may produce serious errors. That, however, would be an exceptional condition, and it is clear that in ordinary open ground the method is accurate, speedy, and cheap for traverse work. With it a measurement in one direction is alone required, the full advantage of tacheometry over rough ground and across obstacles is secured, the temptation to fudging is eliminated, and the constants of the instrument can be accurately determined. At present I have limited its use to traverse in rough country, with success and economy.

CANADA AND THE BRITISH ASSOCIATION.

The annual meetings of the British Association provide a unique opportunity for those interested in any branch of science to foregather for friendly and scientific intercourse, and the policy of holding occasional meetings in the Overseas Dominions maintains that personal touch between the scientific workers of the Empire which is so valuable in its effects. The meeting this year in Toronto gave the members an opportunity for renewing their acquaintanceship with, or seeing for the first time one of the great nations of the British Commonwealth and of observing under the most pleasant and advantageous circumstances the manner in which the special technical and social problems of the country were being handled by the enterprise of its citizens. It is no disparagement of the more formal proceedings of the Association at Toronto to say that these were probably less productive of useful knowledge to the members than the experience of Canadian life, conditions and outlook which the trip afforded. We have already reprinted or otherwise dealt with most of those papers and discussions as were likely to be of interest to our readers. At the conclusion of the Toronto Session the party broke up, the main body going West in two special trains right to the Pacific Coast and returning by a different route. The trains stopped at important cities and places of interest on both journeys, and the hospitality and kindness which marked the reception of the party everywhere will long be remembered. Most, if not all, of the members will by now have returned home, and each according to his peculiar interests will be endeavouring to classify the impressions of several crowded weeks.

With the reflections of the botanists, geologists and other exponents of the natural sciences we have no direct concern, but it may be interesting to suggest some of the thoughts likely to have arisen in the minds of those occupied more particularly with engineering matters. With regard to the Toronto meeting itself one could not help noticing a contrast between the papers contributed by British and Canadian authors respectively. The latter dealt with great works executed or in contemplation, such as the last and greatest of the Niagara developments by the Hydro-Electric Commission of Ontario, the fuller utilisation of the St. Lawrence waterway for navigation and power, and the transportation problems of the Dominion, and so on, all descriptive of engineering work in its real sense. There was a breath of the open air about the Canadian papers, noticeably different from the kind of laboratory atmosphere which hung around many of the British contributions. Of the latter the paper by Mr. E. A. Watson on "Cobalt Magnet Steels," was admirable of its kind, putting forward new knowledge in so orderly and complete a manner that little or nothing further remains to be said on the matter. On the other hand, the "Report of the Committee on Complex Stress Distributions in Engineering Materials" was somewhat disappointing. It was, indeed, not a report at all, but a collection of eight papers by individual members of the Committee, none of which appeared to add anything much to existing knowledge. It is to be hoped that by next year the Committee will be able to produce an agreed report, stating what facts, if any, are definitely proved with regard to the fatigue and fracture of metals, what views still need confirmation, and what beliefs are certainly wrong.

Of the general impressions resulting from the tour, that of the practically universal use of hydro-electric power must have remained in the minds of all the engineers of the party. The admirable work of the Hydro-Electric Commission, culminating in the Queenston-Chippawa Development, the

largest hydro-plant in the world, has provided the whole of Ontario with cheap and abundant power according to a unified system, and has been of incalculable value to the Province. One could not help wishing that a Commission with equal power and ability had been appointed, years ago, to see that the electricity supply of Great Britain was developed on equally sound and far-sighted lines. The province of Quebec is as dependent upon water-power as is Ontario, but excepting Montreal, there are no such large power-consuming communities as Toronto, Hamilton and the manufacturing towns in the neighbourhood. The difficulties in changing established systems, even in a new country, are shown by the persistence of the frequency of 25 cycles for lighting in Toronto. In spite of the fact that most of the lamps are encased in frosted globes, the flickering at times is very unpleasant to a visitor, although the inhabitants do not seem to object. The cheapness of electric light and power is remarkable, the average inclusive nett charge for residential service in Toronto being only 1·05*d.* per kw.-h., although the power has to be transmitted from Niagara 90 miles away. In the town of Niagara Falls itself, a similar service costs 0·75. per kw.-h. The Hydro Electric Commission at present operates 22 water power stations which, when fully developed, will furnish the equivalent of over a million horse-power. The Queenstown plant, which uses 305 ft. of the total difference of 327 ft. between the levels of lakes Erie and Ontario, will develop 600,000 h.p., or an average of 30-h.p. for every cubic foot of water used per second.

Those of the party who took a special interest in hydro-electric developments were also given an opportunity of seeing the Pointe du Bois plant of the City of Winnipeg. The journey to the plant and back involved 150 miles of automobile riding, mainly over roads which would be pronounced impassable in this country, and a further 50 miles in a petrol-driven tramcar over the city's private line, the whole being through most beautiful wooded country. The passage of the cars at a speed of 30 m.p.h. to 40 m.p.h. over roads which, as was remarked at the time, would not be altered in appearance by being ploughed up, exemplified not only the skill of the private drivers who acted as hosts to the party, but also indicated the conditions which must be met by British motor-car manufacturers who wish to do business in the overseas markets. The whole journey, allowing ample time for inspection of the plant and for the necessary meals, was accomplished easily in the day. The construction of the Pointe du Bois plant was decided on by the city in 1906, when the cost of electric power supplied by a private company was 10*d.* per kilowatt-hour. The city now own a plant capable of developing 110,000 h.p., and the average price of current for residential purposes in Winnipeg is 1½*d.* per kilowatt-hour. Transmission over the 77 miles of line from Pointe du Bois to the city is effected at 66,000 volts. It is worthy of note that the most recent transmission lines, both at Winnipeg and Calgary, are of the "H" type with wooden poles connected by a single wooden cross-arm at the top, from the centre and overhanging ends of which the lines are suspended by insulators. This construction is said to be far less liable to breakdowns than the use of steel towers.

The City of Winnipeg Hydro Department, under the management of Mr. J. C. Glassco, started last year to build a steam stand-by plant near the centre of the city. This will contain two 5,000-kw. steam turbines and one of 1,000-kw. capacity, together with the necessary boilers. This plant is specially interesting, as it will also form the nucleus of a central steam-heating system for the city. When the plant is supplying electrical energy the boilers will be fired by pulverised lignite coal, but normally steam will be kept up by electric boilers using the surplus energy of the hydro-electric system. The pipes were being laid in the streets while the visitors were in the city, and it is hoped to get two sections of the city supplied with steam heat before the coming winter. At present the citizens depend upon a high-pressure water service for protection against fire, the pumping station being operated by producer gas engines which are kept always in readiness for duty. The inauguration of the new plant will enable this pumping station to be safely electrified, and, further, the ordinary waterworks steam stand-by station can be eliminated, thus saving a considerable amount in operating expenses. Winnipeg has a population of 283,000, and its total consumption of electricity is something like 250,000,000 kw.-hours per annum. The rivalry between the municipality and the private company who share the supply between them, is, no doubt, partly responsible for this excellent showing, and the figures may be taken to heart by anyone who thinks that any British town is anywhere within sight of its electrical saturation-point.

At Saskatoon, the next important city to be visited, the reception of the visitors took place at the University, and the proceedings included the formal opening of the fine new chemical building. Those interested in concrete work examined the handsome concrete bridge, several hundred feet long across the South Saskatchewan River, and noted the effects of expansion and contraction under the extreme temperature conditions, ranging between limits of 100 deg. F. and —40 deg. F. or thereabouts. Another very fine concrete structure was the Dominion grain elevator, with a capacity for 3,500,000 bushels of wheat. Saskatoon, like Edmonton, Regina, Lethbridge, Moosejaw, and some other Western cities, has to depend upon coal for power purposes, the coal being a lignite of variable quality, according to the district in which it is mined. In all the cities mentioned the generation of electricity and the supply of water are municipal undertakings, and the plants are generally operated in a highly efficient manner. Mention should be made especially of the Regina plant, where the engineer and manager, Mr. E. W. Bull, is generating power from a lignite containing an average of 35 per cent. of moisture. This fuel is not dried in any way before it is fired. It is burned under Babcock and Wilcox land-type boilers on retort-type stokers without arches, and the results obtained are extremely good. Most of the steam stations mentioned are, at least, as well equipped with boiler and engine-room measuring instruments as any corresponding station in this country—coal-weighing apparatus between bunkers and stokers, feed-water meters, steam-flow meters, CO_2 recorders, and other instruments for checking the efficiency of operation being general. The way in which the operating results of each shift are recorded and analysed, especially at Saskatoon and Regina, would be an example to many a British station. Furthermore, the way in which the commercial development of these undertakings has been fostered, so that the average consumption of electricity is from 400 kw.-hours to 500 kw.-hours per head of population per annum, should also be noted by our own authorities.

(To be continued.)

INDIA AND BURMA AT THE BRITISH EMPIRE EXHIBITION.

India, including Burma, is a sub-continent as large as all Europe outside Russia. Its 319,000,000 inhabitants form three-fourths of the inhabitants of the British Empire, or a fifth of the whole population of the world. Nearly a fourth of the population of India, occupying more than a third of the country, is divided among a great number of native States, which vary in area from the size of Italy to a few square miles. Indians are likewise of many diverse races, with as many languages and an indefinite number of dialects, and in a way are divided again into a vast number of castes. The climate of the country, though generally hot, has many grades of temperature; a scientific man travelling one winter in Canada attained a reputation for unexampled mendacity by saying that he had found much colder weather in India during the previous summer than in Canada on his way up the Karakorum mountains. Practically all the country has, however, its monsoon rains from June to October, and as a vast part of the soil is naturally fertile, nine-tenths of the people dwell in the country and get their living off it. Huge tracts are dependent on irrigation for the necessary moisture, and some of the greatest irrigation works in the world have been executed or are in contemplation for turning desert into crop-bearing land. There are also great forests with varieties of hard and decorative woods not yet fully appreciated in the markets of the world, and mineral deposits in active work, though not wholly developed. A great and expanding railway system runs from one end of the continent to the other, and profitably carries an immense traffic at what are probably the cheapest fares in the world.

These vast and complex groups of diverse conditions and activities form the great original that the India Pavilion has to represent in miniature. To collect the huge variety of material that was necessary for any sort of adequate representation would in any circumstances have been a great undertaking, and the conditions in which the collection had to be made increased the difficulty. Before India could be properly associated with the Exhibition not only the Central Government and the Legislative Assembly of India had to sanction and provide a large part of the means for participation, but under the Reformed Constitution each of the executive authorities and legislative assemblies in the chief provinces had independently to arrive at a similar decision, and so had each of the Native States. These decisions, each involving substantial expense to those who took them, had moreover to be taken at a time of acute financial stringency, and, when the several high authorities had agreed, a large part of what had to be exhibited had to be sought from bodies and individual firms through the length and breadth of Indian industry.

When all these circumstances are remembered the dominant impression left by a visit to the India Pavilion is one of amazement at the extent to which those entrusted with the active execution of the undertaking have succeeded in their difficult task. Circumstances have unfortunately prevented the great State of Hyderabad from being represented. Its absence is notable and is deplored; but it throws perhaps into the greater relief the astonishing fact that the Central and each of the Provincial Governments, with the single exception of Hyderabad, and every principal State and a number of others are represented in some form or other in the Pavilion. It will be remembered that it was on the suggestion of the late High Commissioner for India, Sir William Meyer, that the Exhibition was postponed till this year; and the Pavilion gives the best evidence that this prudent delay has been turned to good account by the Exhibition Commissioner for India, Diwan Bahadur T. Vijaraghavacharya and his staff.

An account has already appeared in our issue of April 25, page 527, of the structural and decorative scheme of the India Pavilion, with a view showing its beautiful and impressive effect. Several of the smaller states are exhibiting in the Madras, United Provinces, and Punjab Courts, and in addition to the objects of retrospective art displayed in the Central Hall, a separate Indian Gallery for modern fine art is reserved in the Palace of Art. The Meteorological Department has an exhibit in the Education Court, and the Bombay and Calcutta mints show a varied collection of coins and medals struck for use in India, Ceylon, the Straits Settlements and East Africa. So much of what is most important in the various Courts relates to great works and objects too large to be exhibited that extensive use has been made of models, many of them apt and instructive, and some having a rare beauty. The small objects produced by native handicrafts are shown, for the most part, on the stalls of individual exhibitors, and provide probably the most extensive collection of the traditional Indian domestic arts that has ever been seen in this country. They extend from one end of the Pavilion to the other, and in themselves and their surrounding impress the visitor constantly with an Oriental atmosphere that adds to the interest of his inspection.

Behind the Central Hall is the exhibit of timber and forestry, with which may be taken the exhibit of the Burma Forest Department in the Burma Pavilion and a boathouse outside the Indian Pavilion and facing the Palace of Engineering. These exhibits and the many examples of joinery and flooring in Indian woods to be found in the two pavilions and elsewhere in the exhibition are practically all of hard woods, for, although there is

EXAMPLES OF INDIAN TIMBER AT THE BRITISH EMPIRE EXHIBITION.

Fig. 1.

Fig. 2.

reason for considering that Indian forests contain abundance of material for paper-making, such as is furnished by soft woods, the matter involves technical aspects, which at present are under investigation.

Meanwhile the remarkable forest services of India and Burma have succeeded in the last sixty years, not only in stopping the reckless waste of timber that used to go on in their forests, as, at much later dates, it has been found to go on in those of the Dominions, but has succeeded in making good what damage had been done to such an extent that, in spite of their large annual production of timber, the forests are now estimated to be worth much more than they were at the beginning of that period. While it is believed that the entire timber resources of the Indian Empire are now protected adequately against the possibility of future destruction, unlimited supplies are said to be available of all the commercially valuable timbers that are shown in the pavilion. This statement seems likely enough to be borne out by experience, for, as a fact, about a fourth of the entire area of British India is forest land, mostly of the many varieties of hard or semi-hard woods now exhibited, and adequate arrangements seem to have been made not only for renewing trees that have been felled, but also for gradually removing trees that are without commercial value, and so encouraging the fuller development of those that produce better timber.

The large variety of timbers shown includes examples of what are valuable for constructional or decorative purposes or for both. A pedestal with 28 hinged panels of different Indian and Burmese timbers shows some of the most important, some of them repeated in the panels on the base, and the whole standing on a platform of the extremely durable Burmese pyinkado wood. A still more varied collection of planks and boards is shown in a timber and sample room, and in a two-story building a series of suites designed in different styles show the use of a number of the timbers in structures, panelling, and furniture. The pillars supporting the upper story are each complete young teak trees sawn out from the solid; an unusual construction, used also in other parts of the India and Burma pavilions. It is impossible in a reasonable space even to enumerate the various ways in which these timbers are applied, but they are certainly well worth inspecting, for it may be long before as fine a collection of timber and workmanship is seen again. Fig. 1 on this page shows a church screen of Indian koko-wood designed and made in England, and Fig. 2 a captain's stateroom, made of teak with interior panels of figured wood.

The whole of the timber used in the exhibits has been artificially (kilu) seasoned in planks cut from the green log, taking for 1-in. boards from four to five weeks, and for 3-in. boards from eight to ten weeks; the seasoning is found to be quite satisfactory, and complex structures built up of twenty or thirty pieces cut from such boards and glued together have remained unaltered through the considerable variations of temperature and moisture to which they have been exposed in the pavilions. A still more drastic practical experience has occurred in the Central hall, which is paved with 1-in. ($\frac{7}{8}$ in. finished) Indian Gurjun wood-block flooring laid on concrete. Through unsoundness in the roof this pavement was exposed to rain both before and after the hot spell, but it remains quite flat and little worn, in spite of a considerable traffic. This timber is said to be cheaper than oak and to wear better.

The boat pavilion contains as its principal exhibit the 38-ft. motor-launch Burma Bee, designed and built by Messrs. J. I. Thornycroft and Co., Limited, entirely out of Indian and Burmese timbers, which the builders regard as the strongest and the most durable and attractive woods in the world. The boat is shown in Fig. 3 on the opposite page. The hull is constructed entirely of Burma teak, each plank in the top sides being in one length from end to end. The coamings, hatchways, and deck-house are of Andaman padauk, the interior wood of the aft cabin being laurel and of the fore cabin silver-grey wood. A motor canoe and a skiff by Messrs. Salter Bros., all (including the sculls of the skiff) made of Indian woods, show their suitability for this special class of work; and a section of a composite Great Eastern coach built in Indian gurjun-wood with decorative work in beautifully figured Indian silver-grey wood and Andaman padauk, represents stock that has been running satisfactorily since 1920. A motor-car body in Indian white chuglam and teak, with internal finishings in highly figured laurel-wood, is shown by the side of the boat. The white chuglam is imported in planks with square edges, and it is said that 75 per cent. of these are fit for their intended use, where in ash only 25 per cent. could be used.

In the Palace of Engineering the Birmingham Railway Carriage and Wagon Company, Limited, show two Pullman cars built entirely of Indian gurjun-wood with interior decoration in Andaman padauk, with figured veneer panels inlaid with Andaman and Burma padauk curls respectively, and on the stand of the General Electric Company the Express Lift Company shows a cage fitted throughout in Andaman padauk with finely figured panels. These are excellent examples of the decorative qualities of this timber; and on Messrs. Dorman, Long and Co.'s stand is a fine ship's decking produced from round Burma teak logs. Other notable applications of Indian timbers are the main and a number of other doors of H.M. Government Building, made in laurel-wood and presented by the Indian Forestry Department.

The exhibits in the Pavilion show the most various applications of the timbers for all sorts of purposes, and one exhibit in the south-eastern grounds of the Burma Pavilion, should not be missed. It stands under a large teak log cut into planks, above which are specimens of bamboos and planks of various woods, and it consists of a piece of wharfage front, with piles, camp-sheeting and capping, made of pyinkado or Burma ironwood. This timber is here shown publicly for the first time in this country, and is said to be among the strongest and most durable timbers that is grown. A platform of it is also shown near the section of the Great Eastern coach in the boat-house. It is immune from white ant, and in Burma is used for sleepers when cut from wet green logs, without any seasoning, with better results than other timbers. It would be interesting to know how it resists teredo. While it can be sawn and tooled when fresh, it is difficult to work when old. Its local reputation is certainly very high, and considerable quantities of it are shipped to Bombay and Calcutta.

The railways of India are represented in three courts by a considerable number of models of rolling-stock and some of bridges and other works, which for the most part present no features of novelty. The most interesting is the model of Hardwar Station on a single-line branch of the Oude and Rohilkhand, where from time to time arrangements have to be made to deal with a pilgrim traffic that may run into several hundreds of thousands of passengers, mostly illiterate. The model shows the arrangements by which this abnormal strain is met, and the pilgrims shepherded into the right trains after they have duly bathed in the sacred pool and worshipped at the shrines. In effect they consist in issuing tickets for the several routes from offices marked with flags of distinctive colours, collecting the passengers into similarly flagged enclosures, and interposing between these enclosures and the special trains what may be described as measuring enclosures, holding just a trainful, through which the trains are loaded without overcrowding or confusion.

Nothing perhaps is more remarkable in Indian administration than the elaboration and efficiency of their great co-ordinating services. No parallel, for instance, is probably to be found on a comparable

scale to the manner in which, as described above, the forestry service has safeguarded and developed this great asset in their charge. In a neighbouring court to that devoted to forestry is the exhibit of the Geological Survey. Of the minerals represented the most important are probably the iron ores, of which huge deposits, likely to be among the largest and richest in the world, have been opened up at from 150 miles to 200 miles from Calcutta. The scale on which they are being worked at present is nothing like proportionate to their extent, but examples of pig iron and castings for railway and other purposes by the Bengal Iron Company are shown, and the Tata and Indian Iron and Steel Companies are likewise operating. Specimens are also shown of various grades of charcoal iron, made at the Mysore States' Iron Works, and examples of rough and finished iron from the Central Provinces. Several exhibits show finished iron and steel made by native workers with the crudest traditional appliances. From various working mines are specimens of chromium, copper, gold, silver and zinc-lead, manganese (with several new varieties of ore), tin, titanium and tungsten ores, and of ilmenite and zircon sands from the Travancore beaches, with a number of examples from various districts in India and Burma of metals smelted by natives in ancient ways. Importance is attached to various bauxite deposits, of which specimens are shown, which seem both in quality and quantity to compare very favourably with others that are worked successfully on a large scale in other parts of the world. The available figures of minerals are for British India, including Burma, and the metallic ores reckoned both as metal and ore show a substantial production of gold, lead, manganese, silver and iron in the order named, and a much smaller production of tin, zinc, chromium, tungsten and copper. The commercial value of the monazite sand (from which thoria, ceria, &c., are extracted) is not great in the aggregate, though both in quantity and quality the deposit is the largest and best in the world. Of non-metallic minerals, coal is by far the most important, and specimens are shown from fields in various parts of India, including the large fields in the same district as the great iron deposits to which reference is made above. Among other minerals of importance many specimens are shown of mica, Burma oil shales, marbles, steatite, &c., together with oils and various gems and rare minerals, including pitchblende.

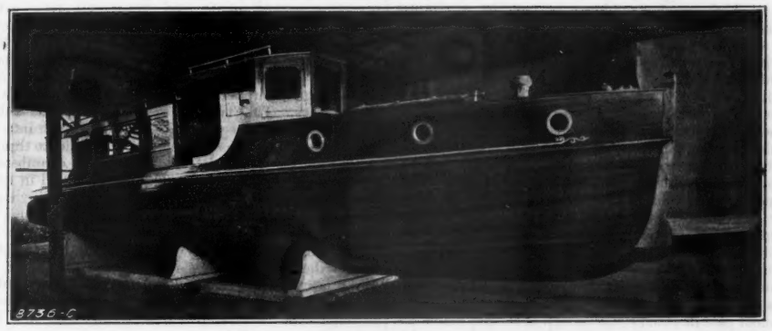


Fig. 3. Thornycroft Launch Built of Indian Timber.

A joint exhibit dealing with co-operation and education is found in the stall opposite the Geological Survey. The subject matter does not lend itself to ocular demonstration, and the stall is small. Its contents, however, are of the utmost importance to an intelligent understanding of the meaning of the Exhibition. Upwards of 12,000,000*l.* are being spent yearly on education. For the time being the proportion of persons, taken all over India, who can read a simple letter and answer it, is under one in twelve. It varies very widely in different parts. In Burma, for example, where children usually attend the monasteries and receive their very elementary education, the overall figure is about one in three; in Travancore, it is better than one in four, and in Cochin than one in five. At the present time some 8¼ million of the 319 million total population are receiving education of some sort. Of these, over 7,000,000 are in primary schools, and over 1,000,000 in not very advanced secondary schools; and of this total over three-fourths are in the lower primary stage, and it is estimated that less than half those who are at school will ever be able to read and answer a letter. Only about 67,000 are attending colleges.

That co-operation should be associated in this exhibit with education is, however, a very practical reminder of the important elements of education that extend into adult life and are not literate. The large majority of the population of India subsists on agriculture. Most of them have to live from hand to mouth, and until recently have had to finance themselves by the help of local money-lenders at very exorbitant rates. In 1904 an Act was passed by the Legislative Council of India, providing for the registration and supervision of such agricultural co-operative societies as might be set up with the object of obtaining credit co-operatively or for similar purposes, and an Amending Act in 1912 extended the scope of such societies to all co-operative purposes. Under the Act, the several Provincial Governments were charged with the appointment of registrars, and an essential part of the business of these officers was to bring the advantages of forming co-operative societies to the notice of those whom such associations might benefit, and generally to give the movement official encouragement. By 1906-7, 740 such societies had been formed, with a total membership stated to be 890, and a capital of 250,000*l.* In 1922 this total had grown to over 56,000 societies, with a membership of over 2,000,000 and a total capital of about 24,000,000*l.* The co-operative movement is said to be entirely non-political, and appears to have the singular distinction of being approved by every party in Indian politics. The extreme parties welcome in it an idealism akin to that which they cherish themselves, while men of moderate views approve it no less warmly because, in practice, the societies have been found to make agriculturists better contented, and to assist the orderly progress of their industry. The movement extends all over India, and the Registrars—independently and, no doubt, unconsciously, adopting the practice of our own Research Department—have sought to create non-official bodies to assist them in their propagandist work, and generally to obtain the help of non-officials. The registrar acts also as a consultant on technical matters to all co-operative societies that seek his advice. The progress of the movement is the more remarkable because the enormous majority of the members of the societies cannot read and answer a letter, and it is estimated that probably not one-fifth of them can even write their own names. When account is taken of the extraordinary rate at which these societies have grown, their present collective strength and the relatively small proportion of the population that they include even now, they seem to be a possible factor of economic progress, of which it would be difficult to exaggerate the importance, particularly if their numbers continue to grow at anything like the rate shown in the last 17 years. Commercially, they seem to be among the most likely avenues of communication between Indian agriculturists and those who make appliances that would be of benefit to them. Though the movement is mainly agricultural, it is not confined to that industry. An interesting illustration of the circumstance mentioned above that the services of senior officers have been placed at the disposal of the Exhibition authorities is seen in the fact that the Registrar of Co-operative Societies for Bengal, Rai Bahadur J. M. Mitra, is in charge of the Bengal Pavilion, and we are indebted to him for much of the information in regard to these societies that has been given above.

(To be continued.)

NOTES ON NEW BOOKS.

It is only natural that there should be an ever-increasing flow of literature dealing with internal-combustion machinery, and in reviewing textbooks concerned with this type of prime mover, we have strongly advocated for some time past that, since the scope is so wide and is rapidly broadening, authors would be well advised to limit the range of the individual volume so as to attempt less, treating more thoroughly with the particular rather than dealing somewhat sketchily with the general. In "*British Oil Engines*," by Mr. W. A. Tookey, M.I.Mech.E. (Percival Marshall and Co., London, E.C., 2*s.* 6*d.* net), the aim has been concisely and clearly to give a good insight into the problems associated with the choice, installation and management of modern heavy oil and paraffin engines. Mr. Tookey's remarks apply principally to land plants. First principles of thermodynamics, theory of machines, and design of prime movers very rightly are not directly dealt with. The point of view of the buyer and user is ever kept in the foreground, and controls the descriptions given, which, it is unnecessary to state, in view of the prominence of the author in this field, are commendably accurate, as also is the reproduction, considering that this is a first edition. It is surprising in such a modest work, comprising some 176 pages in all, with 24 well-chosen and capitally-reproduced illustrations, to find such a wealth of useful information, due to the author's concentration on the user's point of view. Designers and producers will find therein more useful information to guide them than in many comprehensive works purporting to deal almost exclusively with design. Almost all types of oil engines at present in service are dealt with and are taken in order of date of production. This serves as a good guide to the progress made during the last twenty years. Tables of test results of a large number of engines during this period serve as an index to the development, and indicate the results to be expected from the best types to-day. The book is carefully written, is accurate and is excellent value for the very moderate price charged.

Instruction in engine design makes high claims upon competency and upon the judgment of the teacher. The engine is an entity, almost an organism. It may work with different kinds of limbs, but the limbs must be adapted to the organism, though their correlation may imply combination of apparently incompatible conditions. The specialist may give valuable advice as to parts. The professor has to bear the general object and principles in his mind, and must not be tempted into premature specialising, not even by his students. The student may grow tired when he begins to understand that engine design cannot be worked out like mathematical problems by the aid of formulæ such as he finds in engineer's pocket-books, together with the requisite tables of dimensions and constants. But he must not shirk systematic study in the workshop, the lecture hall and at home. Professor R. Grassmann, of the Technical High School, of Karlsruhe, recognises that his *Anleitung zur Berechnung einer Dampf maschine* (Berlin: Julius Springer; price 6·70 dols.) should not in general stand entirely by itself as a text-book of engine calculation and design. Like the previous editions—the volume is the fourth, partly re-written and much enlarged edition—the book is offered to the student in addition to lectures. The statement does not deprive the book of its value for engineers who do not attend Professor Grassmann's lectures. In the first chapters Professor Grassman puts down a definite problem: design a horizontal single-cylinder condensing engine to develop 110 h.p. at 130 r.p.m. working with superheated steam of 320 deg. C. He shows how a problem of this kind should be approached, and discusses the working parts, pointing out in what respects the compound engine would require special treatment; he then proceeds to deal more exhaustively with the valve-gear problems. These deductions occupy 246 pages out of a total of 643 pages. The other two-thirds of the space are taken up by appendices on admissible stresses, pressures on bearings,

accelerations in crank drives, predetermination of steam consumption, indicator diagrams, dynamical problems and other detail intended for the advanced engineer. The whole book is, of course, not written for beginners, and might a little dishearten the reader if it were not for the excellent material. The 471 text figures, paper, type and the general get-up are of the superior type of Messrs. Springer's publications.

For those who wish to follow the progress of service and civil aviation in all parts of the world, convenient and effective means are provided by the issue each year of "*Jane's All the World's Aircraft*," the 1924 edition of which has just made its appearance. The book, which was founded fourteen years ago by Mr. Fred T. Jane and is now compiled and edited by Mr. C. G. Grey, is divided into four parts. The first part gives fully illustrated historical notes on the year's work of each nation in military, naval and civil aviation, together with the names and addresses of aeronautical officials, departments, associations, &c., while the remaining parts deal, respectively, with aeroplanes (including helicopters and gliders), aero engines, and airships. The section on aeroplanes naturally occupies the greater part of the volume and is probably the most useful for reference purposes, since it gives a brief specification of practically every machine in use, with reproductions of photographs and outline diagrams in most cases. Engines are similarly dealt with in the third section, except that the outline diagrams are less numerous; in many cases, however, the engines are shown in a dismantled state in order to illustrate their construction. Only 4 or 5 pages are devoted to the airship section, but these include some interesting line drawings of the German airship L.Z.126, as well as some illustrations of the United States airship Shenandoah. The book, which is well printed and strongly bound in blue-cloth covered boards, is published by Messrs. Sampson Low, Marston and Co., Limited, 100, Southwark-street, S.E. 1, price 2 guineas.

The work of the pioneer as he blazes new routes on untravelled paths, and wrestles successfully with natural difficulties, is not without attractions for those who cannot share in the adventures and hardships he gallantly accepts. From a humble distance, we admire the boldness that conceives the plan, the disregard of danger in its execution, and the fortitude that finally wins achievement. In this spirit we offer our congratulations to M. M. Georges M. Haardt and Louis Andouin-Dechreuil, who, by their simple tale "*Across the Sahara by Motor-Car*" (translated by E. E. Fournier d'Albe, T. Fisher Unwin, London, price 12*s.* 6*d.* net) enable us to follow them in their three weeks' journey from Touggourt to Timbuctoo, in their attempt to utilise this means of transport for opening up the vast horizons of the desert to useful purposes. The scheme had its origin in the enterprise of M. Citroën, who had been impressed by the slowness and inefficiency of the old-world camel caravan during the war. With the fleetest kind of camel, eight or ten weeks are required to traverse the distance, but the pack camel whose load may not exceed 3 cwt., and whose daily rate of progress is 20 miles, requires six or seven months. M. Citroën works and trained staff enabled him to try the experiment of constructing a "caterpillar" car, a modified form of tank, that would travel over broken ground or yielding sand, where fixed roads did not exist. His car for the Sahara voyage has been illustrated and described in Engineering. By the aid of a fleet of five cars the small party, carrying their own necessaries and fuel accomplished their task. The return journey was made from Bourem on the Niger, after the party had made an excursion up that river in search of crocodile and hippopotami. On the return 23 days were occupied, but delays were occasioned by festivities and congratulations. This more leisurely progress over a road already traversed permits the authors to relate tales of folk-lore, and to depict the manner of life of the natives. The authors claim, and with justice, that for the first time mechanism has not only conquered the distance, but all the obstacles accumulated in a most desolate and nightmare country, where superfluity and deficiency unhappily alternate. In the true spirit of adventure they make light of the sufferings occasioned by the heat of day and the frosts at night, the dust and the sand mingling in their food, the dangerous declivities that the cars successfully negotiated, and the fear of attack from hostile natives. These are all forgotten in the fact that the Caterpillar has subdued the desert. It will not be thought any disparagement of a brave and intrepid enterprise to suggest, that as the car has supplanted the camel so the aeroplane may be destined to displace the automobile.

In days past practically every draughtsman had passed through the shops and had a first-hand acquaintanceship with workshop methods. He had also gathered by actually working on them much valuable knowledge as to the properties of various materials of construction, and repair jobs had taught him where trouble might be looked for in the operation of machines. To-day a much smaller proportion of draughtsmen have had this comprehensive experience. Many enter the drawing office directly from the technical school, or after, say, but six months' shop experience, often passed wholly at the marking-off table. The schools, therefore, must attempt to convey to their students in some other way, at least part of the knowledge which the old-time draughtsman had more or less unconsciously assimilated, and thus there is a tendency to elaborate the courses on machine design. The natural result has been the issue of new works on the subject. Amongst these we notice that Messrs. John Wiley and Sons and Messrs. Chapman and Hall, Limited, are publishing at 20*s.* net a second edition of the *Elements of Machine Design*, of which the first edition appeared in 1909. This text book has been compiled by Mr. D. S. Kimball, Dean of the College of Engineering, Cornell, in conjunction with Mr. J. H. Barr, who was formerly Professor of Machine Design at the Sibley College, Cornell. The earlier portion of the text is devoted to a discussion of fundamental principles of design; of straining actions and factors of safety. This is followed by a more detailed discussion of the questions that arise in proportioning machine elements. There is a long chapter on lubrication, giving a good summary of the results of experimental work. Little, however, is said as to the theory, and in the references appended at the end of the chapter no mention is made of Osborne Reynold's classical paper. The text dealing with machine details, contains many valuable observations clearly expressed, and the growing importance of high-speed machinery is met by a chapter discussing the balancing machine parts.

A second treatise dealing with the kindred subject has just been issued by the same publishers. This is entitled *Machine Design Drawing-room Problems*, and its price is 15*s.* net. The author is Professor D. C. Albert, who occupies the chair of machine design at Cornell University. Much of the book consists of tabular matter which includes not only tables relating to the resistance of beams, plates, &c., and of the strength of materials but much useful data as to ordinary proportions of oil grooves, cap screws, washers, split pins and the like, which the young student generally finds particularly difficult to discover. The chapter on factors of safety contains a very valuable summary of a great deal of experimental work and will undoubtedly prove useful to many who have long passed the student stage. The remainder of the volume is for the most part devoted to the design of certain machines. One of these is a pump and each element is discussed in detail. A shearing machine and a drilling machine are similarly dealt with. The work will undoubtedly prove extremely useful for those for which it is intended. The text is clearly written and the observations in general very sound, though as machine design is an art rather than a science there must always be certain minor points on which no two engineers will ever be in complete agreement.

PIETTE COKE OVENS.

By-product coke ovens practically began to find favour in this country only in this century, although some isolated plants of Continental types were erected in England in the 'nineties. Within the period 1898 to 1916 the weight of coal treated in by-product coke ovens increased from 1,250,000 tons to 14,600,000 tons. Yet the number of beehive ovens, 16,037 in 1910, was 6,842 in 1916, and thus still almost equal to that of the by-products ovens, viz., 8,700. Apart from America and the Continent, improvements in by-product coke ovens have been tried rather than adopted since the war. But the gas and coke industry has to study the iron and steel makers, who over here seem to retain a preference for beehive-oven coke, so it has good reasons for maintaining a conservative policy. Low-temperature carbonisation remains in the experimental stage and is hardly yet considered economical anywhere. Many attempts have been made to obtain higher efficiency of the coke-oven plant, and more uniform products by altering the dimensions of the ovens, narrowing their width, and by shortening the coking time. There has been much research on the combustibility of coke; fundamental research on the constitution of coal has also received a new stimulus, and the conviction is gaining ground that the primary fuel problem is to find out what coal really is, lest we defeat by our treatment the main object, utilisation of its constituents to the fullest extent.

There is little inducement at present for the coke industry to abandon approved types of ovens, but progress is, of course, being made, both in design and methods of working and in materials. The use of silica bricks, in preference to silica-clay bricks, almost the standard practice in America, is still tentative in this country. But the large silica ovens recently built at the Shelton Iron Works and at Consett are now in operation. Exhibits illustrating both these plants are conspicuous at the British Empire Exhibition. We describe below the new coke ovens of the Semet-Solvay and Piette Coke Oven Company, Ltd., of Sheffield, with special reference to their battery of 24 coke ovens at the Shelton Iron, Steel and Coal Company, of Stoke-on-Trent. Each of these ovens can produce 60 tons of coke per week. The choice of silica as material was important for the Shelton plant because the Staffordshire coal, rich in volatile matters, cannot by washing be freed of its salt (sodium chloride) which attacks fire bricks. The point was to make the construction sufficiently robust to reduce the liability to repairs and loss of potential output, while securing an even, easily controlled temperature and minimising the quantity of gas necessary for coking the material thus rendering more available for other purposes.

Our illustrations show in Figs. 1 to 4, opposite, sections through an oven and a middle wall, while the diagram given in Fig. 5 on page 512 explains the understructure of a battery. Fig. 6 is a plan of a battery of 66 ovens, while Fig. 7 and the illustrations given in Figs. 8 to 12 on Plates LII and LIII refer to the Shelton plant. Fig. 7 shows the machine used for feeding the coke on to the Robins conveyor, while Figs. 8 and 9 are general views of the coke ovens, the coke hearth is shown in the former, and the Robins conveyor and screen in the latter. Figs. 10 and 11 illustrate the new Shelton coke ramming machine, and Fig. 12 shows the oven face on the ram or pusher side.

The type of oven, illustrated in Figs. 1 to 4, is the Piette reversing regenerative oven, type C, of the Semet-Solvay Piette Company. This oven is of the vertical-flue class, and is provided with reversing arrangements and transverse regenerators placed in longitudinal flues. As Fig. 5 indicates, the understructure of a battery of these Piette ovens consists of five heavy longitudinal walls forming four regenerator chambers, which give a substantial grid support for the overlying oven walls and arches. The two outer longitudinal chambers form the primary regenerators P; they open into the sole flues of the ovens above and communicate through calibrated passages with the two inner chambers or secondary regenerators S. Though arranged in longitudinal chambers, the regenerators are actually transverse. The products of combustion cross through the chequer work in a direction parallel to the oven and travel longitudinally only after arriving in the spaces or distributing chambers *a* of Fig. 3. These are free of filling and are situated on top of the secondary chamber which communicates with the chimney through the reversing valve V of Fig. 5. This valve is operated by gearing at regular intervals of half-an-hour; the valve connects the one or other secondary chamber with the chimney, alternately opening at the same time the air inlet to the other chamber. The heating flues are arranged to lead in groups of about four (3 to 5) from the distributing chambers *a a*, each chamber being fed by an independent gas pipe and regulating cock. The air feed is regulated by dampers placed at each end on the inlets to the sole flues, as well as by proportioning the inlets to each flue or burner, and by appropriate contraction of the areas on top of the flues. Most of these passages and inlets appear of equal dimensions when one glances at the diagrams; they, in fact, vary in dimensions, and are proportioned in accordance with formulæ checked by practice.

The fan T (Fig. 5) draws the air first through the passages *h* in the foundations (Fig. 1), and then through the flues *g* above the secondary generators. In *g* the air takes up the radiated heat of the sole flues, in *h* it recovers the heat radiated in the foundations. The air entering the regenerators is thus preheated to 100 deg. C. or more. From the secondary regenerators the air flows through the passages *i*, which are again not all of equal cross sections, but of pre-determined areas, into the primary generators, to rise at once to the sole flues and to be distributed to the burners. The whole operation is watched through sight-holes of which there is one over each vertical flue on top of the bench; other sight-holes are provided in each half sole flue, in the collecting horizontal flues, and at each of the regenerating chambers.

One of the advantages, claimed for the provision of the primary and secondary chambers with transverse passages, is that the expansion of the regenerator linings and arches and of the communicating ports is independent of the general sub-structure of the batteries, increasing its stability, while the draught will be uniform for all the ovens. The arrangement combines the superior operation of the transverse type with the structural strength of the longitudinal type. On entering the primary regenerator, the temperature of the air will approximately be that of the combustion products, which will leave during the next phase of reversal; the passages *i* will, therefore, be correct as to area for both the phases. These passages are, as stated, proportioned so that the draught will be independent of the position of the oven with respect to the

BRITISH EMPIRE EXHIBITION: PIETTE COKE OVEN.

CONSTRUCTED BY THE SEMET-SOLVAY AND PIETTE COKE OVEN COMPANY, LIMITED, ENGINEERS, SHEFFIELD.

Fig. 1.

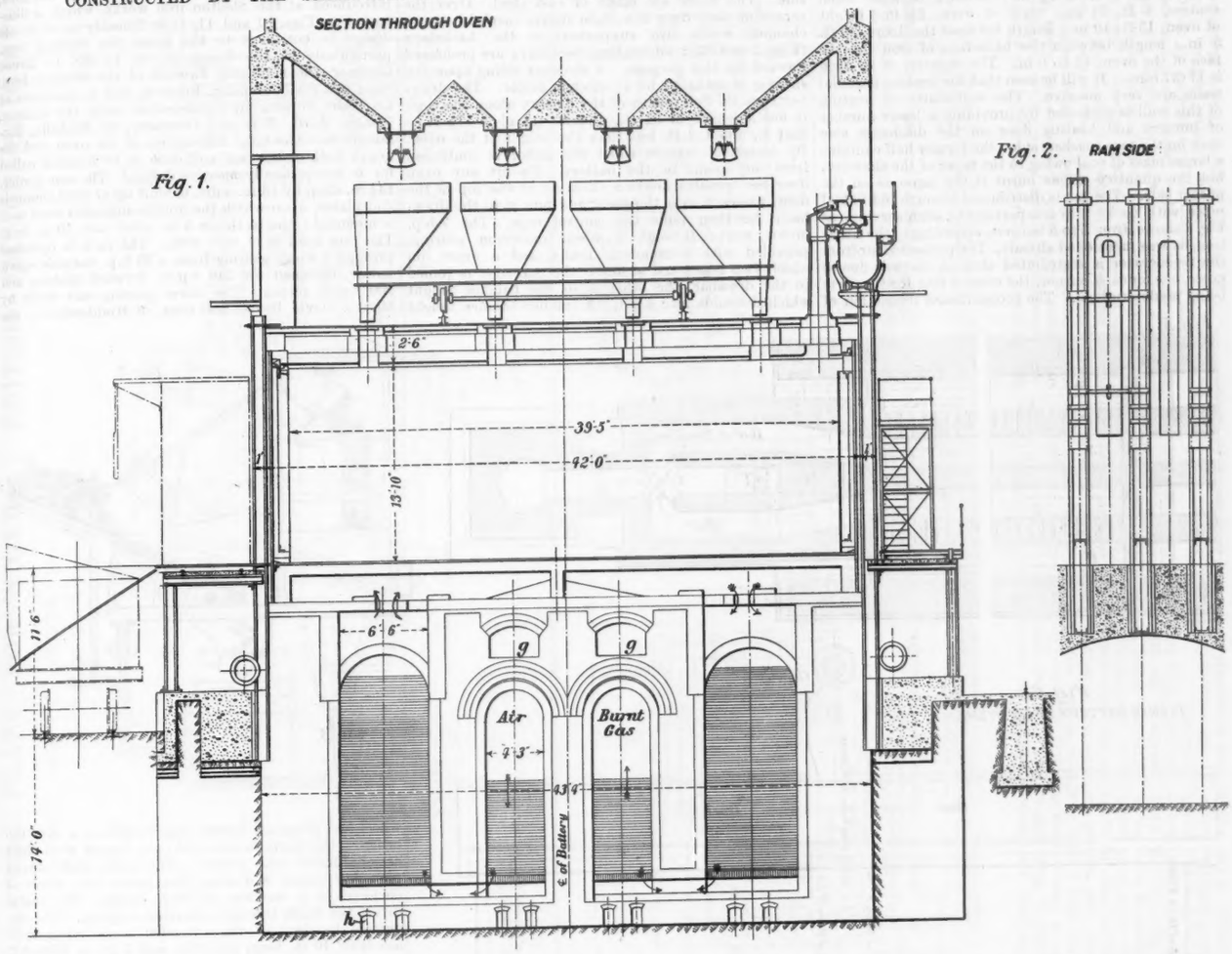


Fig. 2. RAM SIDE

Fig. 3.

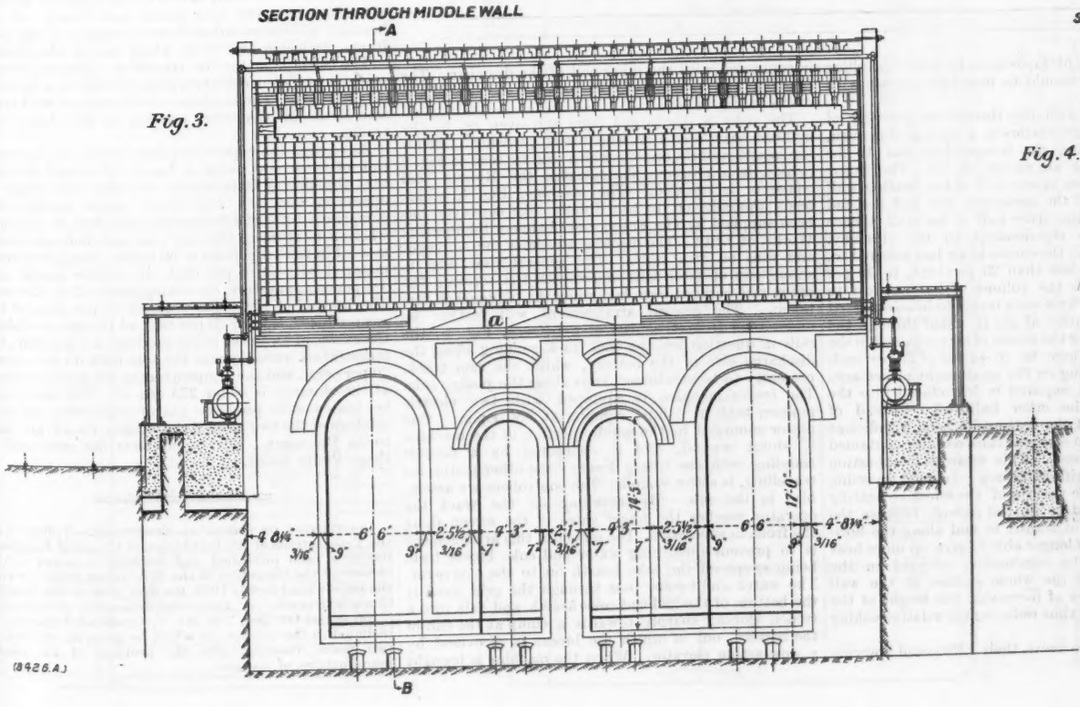
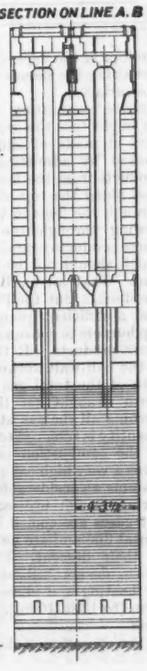


Fig. 4.



(8426 A.)

chimney, which is nearest the ovens, in the middle portion of the battery.

The principal dimensions of the type of oven, illustrated in Figs. 1 to 4, are as follows: width of oven, 1 ft. 6¼ in. to 2 ft. 9¼ in.; distance between oven centres, 4 ft. 3½ in.; taper of oven, 2½ in.; height of oven, 13 ft. 10 in.; length between the doors, 39 ft. 5 in.; length between the backstays of iron on the face of the oven, 42 ft. 0 in. The capacity of an oven is 17·37 tons. It will be seen that the heating (middle) walls are very massive. The uniformity of heating of this wall is perfected by providing a lesser number of burners and heating flues on the discharge side than on the ram (pusher) side; the former half contains a larger mass of coal owing to the taper of the chamber, but the quantity of gas burnt is the same as on the pusher side. The gas is distributed through individual pipes with cocks into compartments, each serving, as Fig. 3 shows, from 3 to 5 burners, according to the situation, as was mentioned already. The preheated air from the regenerator is distributed through the sole flue to ports, one for each burner, the correct area for the ports being predetermined. The proportioned restriction of the tops of the flues is of importance for gases travelling upwards; the flames should be in actual contact with the surfaces.

Since combustion with the theoretical quantity of air might fuse the regenerators in a vertical flue oven, even if made of silica, the temperature has to be limited by admitting an excess of air. The burnt products from the flues in one half of the heating wall pass along the top of the horizontal flue and descend through the flues in the other half of the wall, thence flowing through the regenerators to the chimney. These products contain the excess of air just referred to, which should not be less than 25 per cent. to 30 per cent. That air swells the volume of hot gas lost to the stack. But the Piette oven is said to be so operated that a sufficient quantity of gas is added through the top burners to consume the excess of air contained in the burnt products. If there be an excess of 25 per cent. in the half-wall working on the up-draught phase, one-fifth of the total gas required is introduced into the down draught on the other half-wall. Instead of burning all the gas at the bottom burners, a sufficient quantity is reserved to consume the excess air contained in the combustion gases. This retarded combustion gives a very high calorific efficiency. In most reversing systems a considerable portion of the effective heating surface is not utilised to its full extent, because the hot gases are cooled in transit to and along the horizontal flue and are no longer able to give up more heat in their descent. The combustion adopted in the Piette design utilises the whole surface of the wall for heating and allows of increasing the height of the oven (to 13 ft. 10 in.), thus reducing the relative coking time.

The operation of the doors, their lifting and lowering is not effected in the usual way by means of travelling winches, but by the aid of an electric motor and a drawbar. The arrangements are nearly, though not quite, the same on the discharge side as on the pusher side. The doors are made of cast steel. Over the centre of each door is a chain sheave carried between channels which are supported on the backstays (Figs. 2 and 12); alternating backstays are prolonged upward for this purpose. A drawbar riding upon the sheaves is actuated by an electric motor. The drawbar runs the full length of the battery along the top; it has a length of 91 ft., and its travel is 11½ ft.—that is, about 2 ft. less than the height of the oven. By means of tension ropes the motor is controlled from any point in the battery. To lift any oven door the operator hooks a chain on to the top of the door, passes it over the sheaf and pins it to the drawbar; he then pulls the control rope. The 7-h.p. motor works through a worm reduction gearing, provided with a magnetic brake, and a drum, on which two ropes are wound; the one rope is joined to the drawbar, the other holds the balance weight which descends into a pit. A smaller balance weight is connected with the other end of the drawbar. The drawbar and sheaves will be seen on the top of the ovens in Fig. 8.

The coke is discharged from the oven on to the inclined coke hearth on which it is quenched. Below the hearth and its screen, which can be seen in Fig. 9 (which is a progress photograph), the Robins coal conveyor is situated. The machine, Fig. 7, which feeds the coke on to the Robins coke conveyor has been supplied by The Fraser and Chalmers Engineering Works, of Erith. The machine straddles the conveyor and runs on two rails. The general view, Fig. 9, shows one of these rails underneath the screen; the other rail had not been laid when the photograph was taken. The general arrangement will further be understood from the plan of a battery, Fig. 6; the rails in question are the coal track running along the discharge side of the battery, whilst the ram track, presently to be mentioned, runs along the pusher side. The feeder machine is equipped with two electric motors, both of 5 h.p., running at 550 r.p.m. One motor mounted in the middle portion of the machine is shunt wound, and is connected by a flexible coupling with the rotary feeder; the other motor, for travelling, is series-wound. The controllers are assembled in the cab. By travelling on the track the operator reaches the finger gates of the screen along the front in succession. The object of this arrangement is to prevent quenching water and coke breeze from being swept off the coke hearth on to the conveyor. The water and breeze pass through the grid fixed at the bottom of the inclined coke hearth and fall into a trench sloping sharply towards a sump at the end of the battery, out of which the breeze is recovered by a slow-acting elevator. When the machine is brought into position opposite any part of the hearth, the operator opens the corresponding finger gate and the coke falls on to the conveyor, as shown in Fig. 7.

The coal-levelling and coke-ramming machine, introduced at the Shelton iron works, which is illustrated in Figs. 10 and 11, is sufficiently novel in its design to entitle it to the name the Shelton ram, particularly as the design is due to Mr. C. Bruce Gardner, the managing director of the Shelton Iron, Steel and Coal Company, Limited, and to members of his staff, working in collaboration with the makers, Messrs. M. B. Wild and Company, of Nechells, Birmingham. The large dimensions of the oven and the heavy bulk of the coal and coke to be handled called for an exceptionally massive design. The ram girder, 14½ in. deep by 13 in. wide, is built up of steel channels and plates, upon which the double-shrouded steel rack is mounted; the teeth are 3 in. pitch and 10 in. face. The ram head is of cast steel. The rack is operated through a worm gearing from a 30 h.p. variable speed motor, designed for 240 r.p.m. forward motion and 800 r.p.m. return. The worm gearing was made by Messrs. David Brown and Sons, of Huddersfield; the wheel is a phosphor bronze ring shrunk on a cast-iron centre; the worm is cut solid on a forged steel shaft case-hardened and ground. The worm shaft runs in phosphor-bronze self-oiling bearings; the whole is enclosed in a cast-iron oil-bath casing. The motor drives the worm through a flexible coupling. The two outside bearings of the extended worm-wheel shaft are both 10 in. long, and 6 in. and 7 in. in diameter, respectively; the shaft drives the rack pinion through a machine-cut steel spur pinion and wheel. All the bearings are assembled and cast integrally in one steel frame, to which the worm-wheel case is also bolted.

The 30 h.p. motor for travelling operates through machine-cut spur-reduction gear, enclosed in a cast-iron oil-tight box. The machine travels on four steel-tyred wheels, 30 in. diameter, running on two heavy rail tracks.

As regards the experience, upon which the construction of these new ovens is based, we should mention that the twenty installations of Piette coke ovens in operation and the nine more under construction comprise a total of 1,841 ovens. At Moll, in Belgium, where a mixture of Durham coal and Belgium coal is treated in the proportion of 60 to 40, giving an average material with 26·5 per cent. of volatile matter and 4·5 per cent. moisture, the coking time is 21 to 22 hours. The heating of the ovens requires 42 per cent. of the gas produced, leaving 58 per cent. of the gas available; the excess of air in the burnt products is 3 per cent., the temperature variations in the sole flues do not exceed 20 per cent., and the temperature of the burnt products at the chimney is below 275 deg. C. The ovens may be heated with producer gas or coke oven gas or a mixture of the two gases; the results stated are said to be the same. The by-products are recovered in these Piette ovens.

Fig. 5.

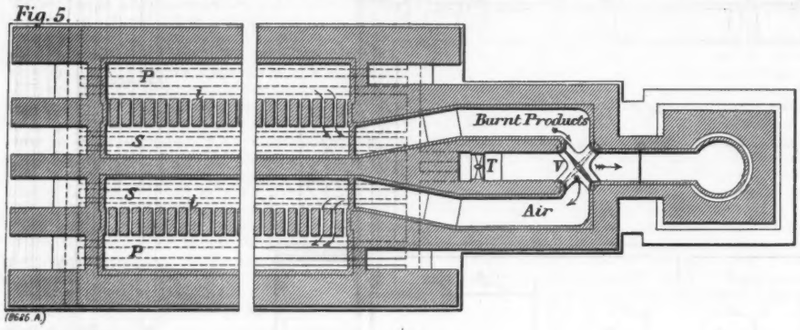


Fig. 6.
PLAN OF BATTERY OF 66 OVENS

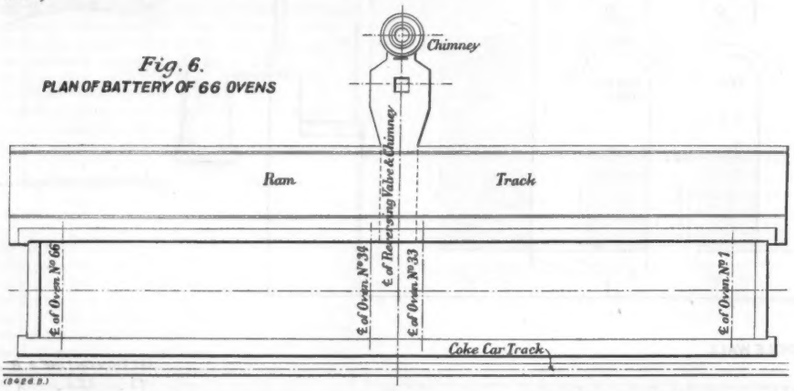
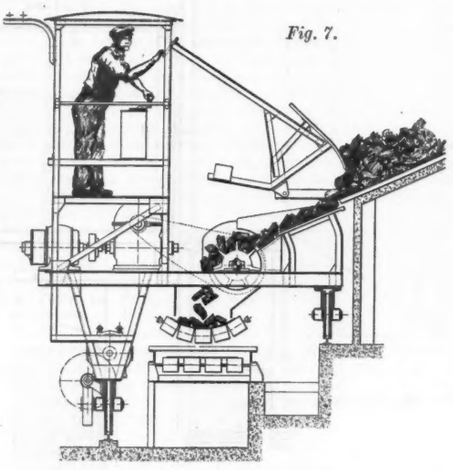


Fig. 7.



Institution of Chemical Engineers.—Volume I of the Transactions of the Institution of Chemical Engineers has now been published and contains a record of the history of the formation of the Institution, together with the papers read during 1923, the first year of the Institution's existence. A very comprehensive contribution "Industrial Oxygen," by Mr. T. Campbell Finlayson is included in the volume, in which he gives an account of two years' research into the problem of the cheap manufacture of oxygen.

PALM-OIL EXTRACTING AND KERNEL-SEPARATING PLANT FOR NIGERIA; BRITISH EMPIRE EXHIBITION.

PALM-OIL EXTRACTING AND KERNEL-SEPARATING PLANT FOR NIGERIA; BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. MANLOVE, ALLIOTT AND CO., LIMITED, ENGINEERS, NOTTINGHAM.

Fig. 1.

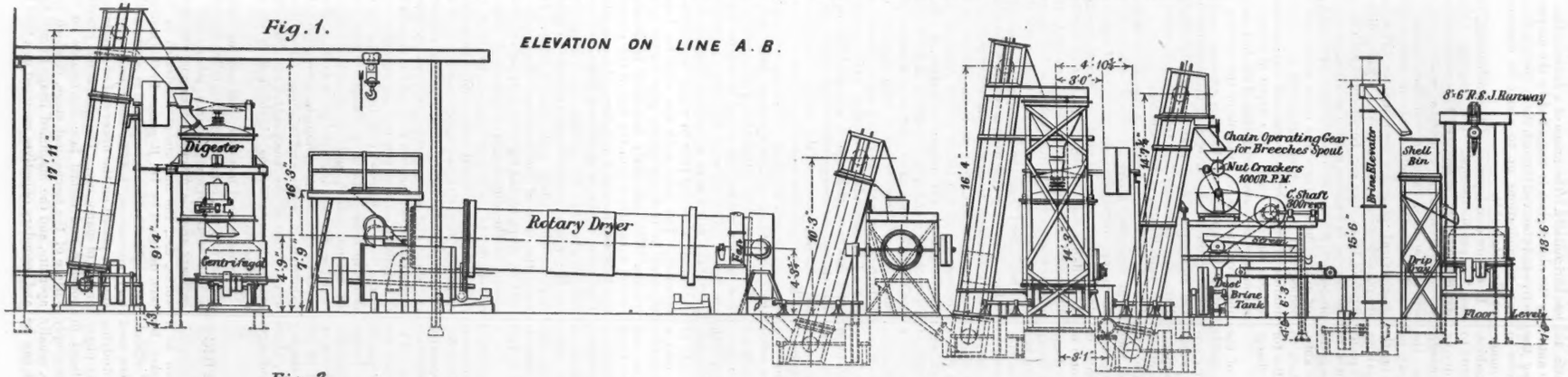
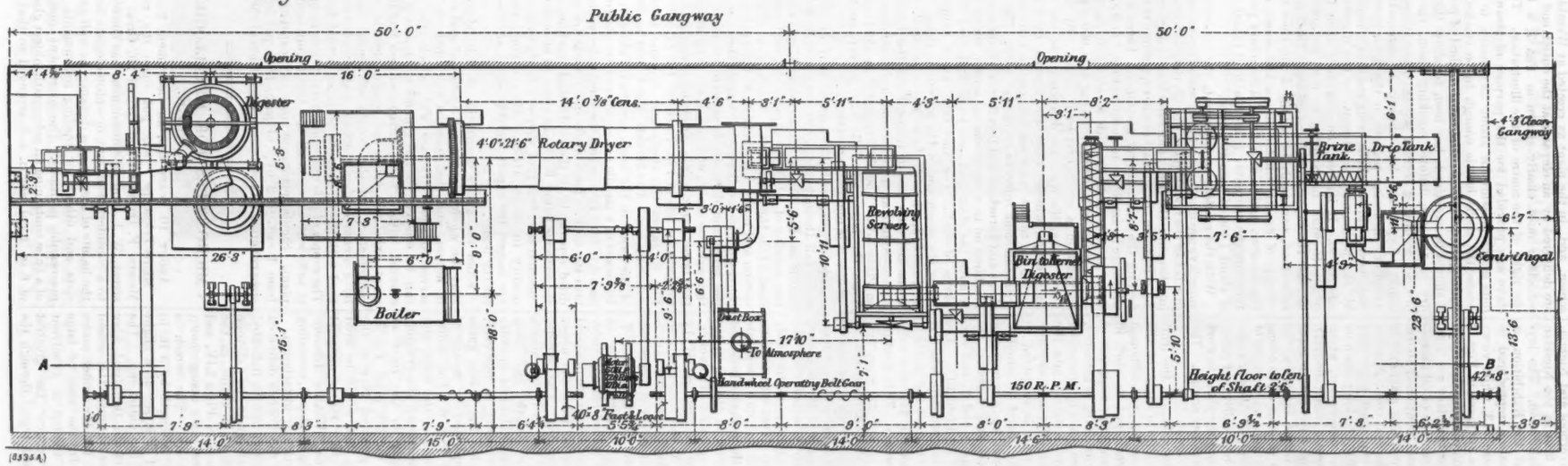


Fig. 2.



(8336 A.)

PALM-OIL EXTRACTION PLANT.

AMONG the many industrial processes which are demonstrated in actual operation at the British Empire Exhibition, is the extraction of palm oil, which is largely used in this country for soap manufacture, and also, after bleaching and refining, for edible purposes. Palm oil is an orange- or red-coloured substance, which is solid at ordinary temperatures, and is obtained from the fibrous pericarp of the palm fruit. The palm trees producing this fruit grow wild in various tropical countries, notably West Africa, although they are often cultivated on account of the commercial value of the oil. The fruits are obtainable practically all the year round in West Africa, but the supply is most abundant in that country in the period from December to March, after a light, cool wind, known as the "hammatan," has ripened the fruits. The latter grow in clusters from 10 in. to 12 in. in diameter, and from 12 in. to 18 in. in length, each individual fruit measuring about 1½ in. in length, and about ¾ in. in diameter. The pericarp, which contains the palm oil, covers the hard thick shell of a nut, about the size of a filbert, and in this shell is a kernel from which palm-kernel oil is extracted. On an average, about 45 per cent. by weight of the fruit is palm oil, the remainder being accounted for by the nut, fibre and moisture. Palm-kernel oil is a more valuable product than the palm oil with which we are now mainly concerned, and the kernels are imported into this country for the extraction of the oil for use in margarine manufacture, the refuse being employed as a foodstuff for cattle. The palm oil, however, is extracted where the fruit is produced for economic reasons in the matter of transport, and also because the ripe fruit is liable to decompose in a few days after gathering.

The usual method of extracting the palm oil has been first to separate the pericarp from the nut in machines known as depericarping machines, and afterwards to express the oil from the pericarp by employing hydraulic presses. The plant, however, was costly and we understand that the depericarping machines, which employ rapidly-revolving knives, have been the source of considerable trouble. Another method used has been to treat the separated pericarp in heated centrifugal machines for extracting the oil, but although the plant for this process was less costly, the difficulties with the depericarping machines still remained.

The plant which we now propose to describe has been manufactured by Messrs. Manlove, Alliott and Co., Limited, Bloomsgrove Works, Nottingham, for

Nigerian Products, Limited, of Liverpool and Nigeria, and it is exhibited by the latter firm in the Nigerian section of the British Empire Exhibition. The lay-out of the plant, as arranged at the Exhibition, is illustrated by the plan and elevation reproduced in Figs. 1 and 2, respectively, on page 513, while views of the more important components are given in Figs. 3 to 8, on Plates LIV and LV, accompanying this issue. The distinctive features claimed for the plant are that, in addition to giving a higher percentage of oil extraction than is obtained by the processes mentioned above, it avoids the use of either depericarping machines or hydraulic presses, thus reducing the first cost. Another important point, which will be explained more fully later, is that provision is made for cracking the nuts and separating the kernels in the same plant, which thus produces palm oil and palm kernels simultaneously. The usual practice, we understand, has been to leave the nuts to dry for several weeks before extracting the kernels. The plant illustrated is capable of handling 1 ton of palm fruit per hour, yielding an average of 4 to 5 cwt. of oil and 3 cwt. of kernels. This is about equal to the productive capacity of a cultivated palm-fruit estate of 35,000 acres, assuming the plant to work for 10 hours a day and for 300 days per annum. The plant requires about 60-h.p. to drive it.

In the process of extracting the palm oil, the fruit travels through the plant from left to right of the lay-out as illustrated in Figs. 1 and 2, and although the arrangement of the plant when put to work in Nigeria will be somewhat different, the sequence of operations will be the same. The ripe fruit, as gathered, is stored in bins and supplied to the plant by conveyors as required. It is delivered, as received, into the boot of a bucket elevator, which lifts and deposits it into a digester. In this the fruit is subjected to the action of low-pressure steam for about 20 minutes, and at the same time it is stirred by a number of revolving paddles. The elevator and digester are shown on the extreme left of Figs. 1 and 2, and also in the half-tone engraving, Fig. 3 on Plate LIV. The steam has the effect of softening the pericarp, which is removed from the nuts by the action of the paddles, eventually leaving a mass of mixed oil, fibre and nuts, with water from the condensed steam. This mixture is run out of the digester into a centrifugal separator, from which the greater part of the oil runs into an open tank located underneath the digester, as can be seen in Fig. 4. The nuts and fibre which remain in the centrifugal together with most of the moisture, are then steamed to release the remainder of the oil, the centrifugal, of course, running continuously throughout the whole operation. The oil resulting from the steaming process may be run into a separate tank as it is of a lower grade than that which first runs off. Not more than 3 per cent. of the oil in the pericarp remains behind after the operation of steaming.

The basket of the centrifugal is then raised by lifting tackle, as shown in Fig. 5, the contents, consisting of wet nuts and fibre, being dumped into a hopper whence they are delivered into the upper end of an inclined rotary drier shown in Figs. 1 and 2, as well as in all the photographic illustrations on Plate LIV. The drier consists of a steel-plate cylinder fitted internally with inclined vanes which are designed to assist the motion of the material from the upper to the lower end as the cylinder rotates. The cylinder is 4 ft. in diameter, and would be 30 ft. in length in the ordinary way, but the length has been reduced to 21 ft. 6 in. in the plant exhibited in order to economise space. Drying is effected, in this case, by drawing through the cylinder the waste gases from a boiler, this being accomplished by means of the exhaust fan best shown in Fig. 6. The boiler itself is located near the upper end of the drier, and is distinguishable in the last-mentioned illustration; it can be seen on a larger scale on the right of Fig. 4, and is clearly indicated on the plan, Fig. 2. This boiler is of the Bonecourt gas-fired type in the plant as exhibited at Wembley, but would be fired by the dried waste fibre and other refuse material under normal working conditions. Various different methods of heating the drier can be employed, according to the circumstances of each particular installation.

The material discharged from the drier is delivered by a bucket elevator into a rotating screen indicated in Figs. 1 and 2, but not clearly shown in the half-tone engravings. A small portion of it is visible in the bottom right-hand corner of Fig. 6 on Plate LIV, and it is actually enclosed in the steel-plate casing shown on the right of Fig. 7 on Plate LV. The screen is of hexagonal cross section, 9 ft. in length by 3 ft. in diameter across the angles, and it is set at a slight inclination downwards towards the outlet end. The object of the screen is to separate the dried fibre from the nuts, the fibre falling through the screen being removed for use as fuel for the boiler under normal working conditions. In the case of large installations, this fibre may be treated in a solvent extraction plant in order to recover the greatest possible amount of oil. The nuts travel through the screen, and, in the plant as erected at Wembley, they are delivered by an elevator at the outlet end into an autoclave most clearly shown in Fig. 7, a little to the right of the centre of the illustration. The autoclave was provided for the purpose of steaming the nuts under pressure for about 15 minutes, in order to render the shells brittle enough to be cracked immediately after removal. The usual method of procedure, it should be explained, has been to allow the nuts to dry in the sun before cracking them, the drying process occupying several weeks under those conditions. Experience has shown, however, that the secondary steaming process in the autoclave can be dispensed with, the shells being made sufficiently brittle by the preliminary treatment in the digester above referred to. It is therefore proposed, when the plant is put to work in Nigeria, to use the autoclave to increase the capacity of the digester. This, it may be mentioned, can easily be arranged for, since the autoclave is of exactly similar design and construction to the digester, and is also fitted with rotary paddles for agitating the contents; it is capable of taking a charge of about 1 ton of nuts at a time.

With the existing arrangement, the contents of the autoclave are discharged into a worm conveyor, visible just below the floor level in Fig. 7, the conveyor delivering them into the boot of another bucket elevator, which deposits them through a breeches spout into the hoppers feeding the nut-cracking machines. These machines, which are in duplicate as shown in Figs. 7 and 8, are constructed in accordance with Knox's patents, and they each consist of a drum rotating at 1,000 r.p.m. and enclosed in a stout cast-iron casing. By means of worm feeds, the nuts are delivered into the centre of each drum, whence they are thrown by centrifugal action on to the inner surface of the cast-iron casing with sufficient force to crack the shells. The cracked shells and kernels mixed together fall from the cracking machines on to a reciprocating screen, which serves to remove the dust and also to separate out the larger pieces of shell. The dust falls into a hopper placed below the upper end of the screen, as shown in Fig. 1 on page 513, while the large pieces of shell, with any uncracked nuts, are delivered from the lower end of the screen into an inclined trough, best shown in Fig. 8 on Plate LV. The shell collected in the trough slides down the latter and falls into a heap on the floor, whence it is removed at intervals.

The kernels, with the greater part of the broken shell, fall through the screen into a tank below, also shown in Fig. 8, this tank being filled with brine, the density of which is adjusted so that the kernels float while the shells sink. The tank is triangular in section and in the bottom of it, at the apex, is a worm conveyor which collects the shells as they sink through the brine and delivers them into a bucket elevator, the cast-iron casing of which is in communication with the brine tank. This elevator, which can be seen towards the left of Fig. 7 and on the extreme right of Fig. 8, raises the shells and deposits them into a receiving bin. The kernels, which float on the surface of the brine in the tank, are drawn along to one end by means of a paddle conveyor, and are placed by hand on a drip tray from which the surplus brine drains back into the tank. Both shells and kernels are afterwards dried separately in the centrifugal machine shown on the extreme left of Fig. 7, in order to recover the brine, common salt, being, of course, a fairly expensive commodity in West Africa. After drying, the kernels are bagged for export and the shells are used as fuel for the boiler.

From the above description it will be understood that the whole plant is self-contained and continuous in action, and the example exhibited at Wembley serves to show the ease with which the apparatus can be erected on the ground level and afterwards covered with a light, corrugated-iron building. The plant exhibited is driven by an electric motor for convenience, but this would, of course, be replaced by a steam engine supplied with steam from boilers fired with the refuse material in an actual installation. The supply of this refuse material, it may be mentioned, is sufficient to meet all the fuel requirements of the plant. Similar plants are made with capacities ranging from 1 cwt. to 2 tons of palm fruit per hour, these sizes covering all the usual requirements of the industry.

MICROSCOPES FOR METALLOGRAPHIC WORK.

About 10 years ago, an instrument known as a "Micro-Telescope" was put upon the market by Messrs. F. Davidson and Co., of 29, Great Portland-street, W. 1., and this instrument has since been used to a considerable extent by entomologists for studying the habits of insects at a distance, as well as by physicists and others for reading instruments placed in inaccessible positions. The instrument consists simply of a tube containing an achromatic object glass, usually of 6 in. focal length, and arranged so that it can be screwed on to the lower side of the stage of an ordinary compound microscope used with its axis set more or less horizontally. The image of a distant object formed by the object glass is magnified by the microscope objective and observed through the eyepiece in the ordinary way, magnifications up to about 50 diameters being readily obtainable.

In a later development of the instrument, known as the "Super-Microscope," the telescope object-glass, above referred to, is replaced by a comparatively low-powered microscope objective with an additional achromatic lens, called a collector, located between it and the ordinary microscope objective. With this arrangement magnifications up to 1,000 diameters are possible with a much greater working distance and depth of focus than can be obtained with an ordinary microscope having the same magnifying power. These properties render the instrument particularly useful for examining fractures and other rough and irregular bodies, and it has been employed in a considerable number of engineering works and testing laboratories for this class of work. The depth of focus available, of course, corresponds with that of the first, or primary, objective, and, as an example of the working distance obtained, we may say that this amounts to 8 in. with a 4 in. primary objective, a 1¼ in. secondary objective and an eyepiece having an initial magnification of 8 diameters, although the total magnification, with a 9-in. tube length, is 40 diameters.

While high magnification is possible with the instrument described above, it is not suitable for critical microscopy owing, mainly, to lack of rigidity in the stand. With the form of stand recently designed with the collaboration of Dr. F. Rogers of Sheffield, and illustrated in Fig. 1 opposite, however, the same optical system has been adapted to the highest class of visual and micro-photographic work in metallurgy, as will be evident from the microphotographs reproduced in Figs. 2 and 3, which were taken with the instrument. Fig. 2, it will be seen, shows lamellar pearlite in a 0·4 per cent. carbon steel at a magnification of 5,000 diameters, and was taken with a $\frac{1}{12}$-in. oil immersion fluorite lens as the primary objective, a 1-in. lens as the secondary and a + 4 eyepiece in addition. Fig. 3 is a microphotograph of cast iron showing phosphide eutectic and pearlite at a magnification of 1,000 diameters, and was taken with a ½-in. primary objective and a ¼-in. secondary objective. We should perhaps point out here, although it will doubtless be obvious, that the optical arrangement adopted does not increase the resolving power of the primary objective, *i.e.*, its ability to separate exceedingly fine structure. The resolving power, however, is not impaired, as is usually the case with very high eyepiece magnification.

The instrument illustrated comprises a cast-iron base with a mechanical stage shown on the right of the figure. The primary objective is screwed into a fixed tube fitted with a vertical illuminator and also containing a sliding tube in which the collector lens is mounted. The tube with the collector lens can be adjusted by rack and pinion gear visible in the illustration. The secondary objective is mounted in a second tube fitting into the end of the primary-objective tube and provided with fine and coarse adjustment. This tube works in machined slides secured to the base, as also does the mechanical stage above referred to, the whole arrangement ensuring accurate alignment in conjunction with great rigidity. For visual work, the tube of the secondary microscope is fitted with an eyepiece, but for photographic work the camera shown in the illustration is provided. This is connected to the secondary microscope by a light-trap formed by two co-axial tubes, and is mounted on stout mahogany bars clamped to the cast-iron base by means of bolts and fly-nuts. Fine focusing adjustments to the stage and the secondary microscope tube can be carried out from the screen end of the camera by means of rods fitted on each side and having pulleys connected to the focusing screws by flexible cords. The camera is made to take half-plates, which are well covered at all magnifications, and we should, perhaps, explain that the microphotographs given in Figs. 2 and 3 are portions of half-plate photographs reproduced without reduction in scale and without retouching in any way. Some of the finest detail visible in the photographs, however, is unavoidably lost in the process of reproduction.

The instrument just described, although quite simple and easy to use, is intended mainly for high-class work in the metallurgical research laboratory. For the ordinary routine practice of engineering works, steel works, &c., the instrument illustrated in Fig. 4 has been designed by Dr. Rogers. In this instrument, the same optical system is employed as is used in the laboratory microscope, but, in the former, the mechanical stage is placed on the upper end of a rectangular tube or box of mahogany. The specimen is placed with the polished and etched face downwards on the upper surface of the mechanical stage, in which there is an aperture, and the magnified image formed by primary and secondary objectives mounted in a tube below the

MICROSCOPES FOR METALLOGRAPHIC WORK.

CONSTRUCTED BY MESSRS. F. DAVIDSON AND CO., LONDON.

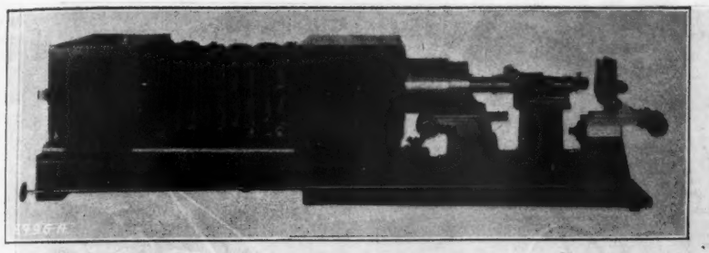


Fig. 1. High-Powered Microscope Arranged for Microphotography.

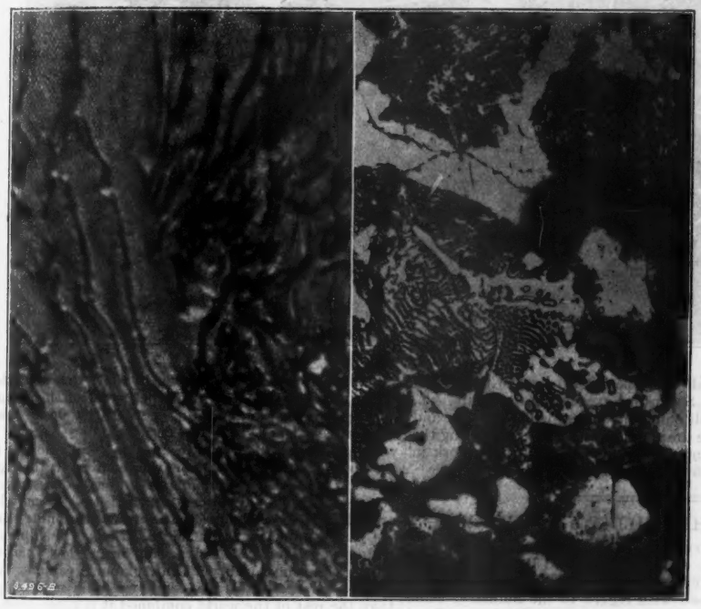


Fig. 2. Lamellar Pearlite in 0·4 per Cent. Carbon Steel at 5,000 Diameters.

Fig. 3. Cast Iron at 1,000 Diameters.

Fig. 5. Cast Bronze at 100 Diameters.

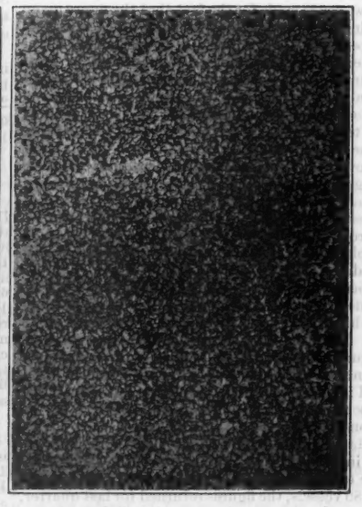


Fig. 6. Mild Steel 0·25 per Cent. Carbon at 100 Diameters.

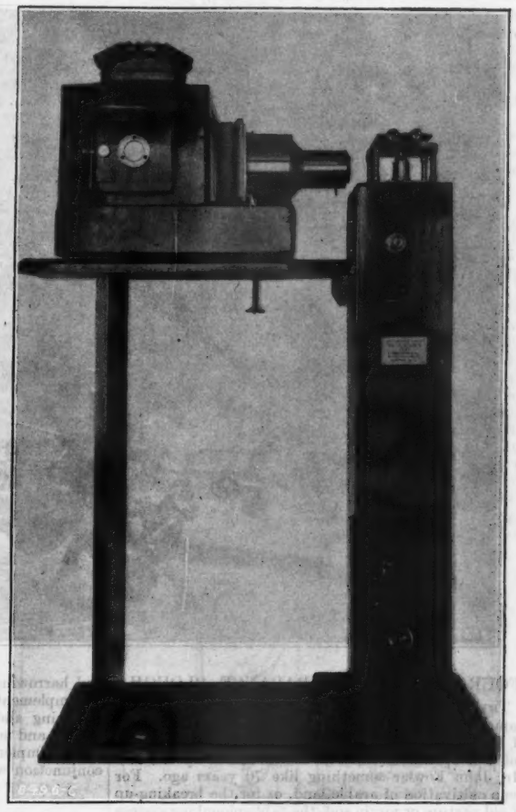


Fig. 4. Microphotographic Apparatus for Works Use.

stage, is received on a white screen at the bottom of the box. The image can be examined through a door in the side of the box and focused by rack-and-pinion gear, the milled-edge disc of which is shown in the illustration near the upper end of the box; the focusing gear moves the secondary objective only. After the desired portion of the specimen has been selected by the adjustment of the mechanical stage, a dark slide containing a photographic plate of quarter-plate size is inserted in place of the focusing screen and the exposure made. Light is supplied by a Pointolite lamp contained in the optical lantern which forms a prominent feature of Fig. 4, the beam of light being projected on to a vertical illuminator fitted in the microscope tube just below the primary objective.

The workshop form of microscope is intended to be used for one magnification only, and is supplied for magnifications of 100, 250, or 500 diameters, as required. The exposure necessary with a magnification of 100 diameters is only about 2 seconds with special rapid plates, and it is therefore possible to take microphotographs at the rate of 100 per hour on purely repetition work. Two examples of the work of this instrument are reproduced in Figs. 5 and 6, of which the former shows the structure of a cast bronze and the latter that of a 0·25 per cent. carbon steel, both at a magnification of 100 diameters. For this magnification, the focal lengths of the primary and secondary objectives are $\frac{3}{4}$ in. and $1\frac{1}{2}$ in., respectively.

Messrs. Davidson manufacture both types of instrument, which can, of course, be employed for other than metallographic work. The high-powered microscope has, in fact, been used with very satisfactory results in connection with bacteriological investigations and medical research work.

The City and Guilds Technological Courses.—Next year's programme for the examinations in technology of the City and Guilds of London Institute has now been published by Messrs. John Murray, at 3*s.* 6*d.* net. Few changes have been made, and these relate mainly to the chemical and textile industries. The syllabus now covers 79 subjects. The needs of engineers are particularly well met, papers being set in mechanical and electrical engineering, boiler-making, naval architecture, motor-car engineering, and aeronautical engineering. In addition there are courses on electrical installation work, on engineering as applied to the cotton industry, and also on iron and steel making, and the metallurgy of the non-ferrous metals. Handicraft examinations are also provided for. The examination in mechanical engineering is divided into two divisions, of which the first is intended for engineer assistants, draughtsmen and designers, and the other for those engaged in the shops. The offices of the Institute are at 29, Roland Gardens, London, S.W. 7.

FOUR-FURROW ANTI-BALANCE CABLE PLOUGH; EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. JOHN FOWLER AND CO. (LEEDS), LIMITED, ENGINEERS, LEEDS.

FOUR-FURROW ANTI-BALANCE PLOUGH.

The cable-ploughing system associated with the name of Messrs. John Fowler and Co. (Leeds), Limited, of Leeds, has always held a prominent place in agricultural operations since it was invented by the late Mr. John Fowler something like 70 years ago. For deep cultivation of arable land, or for the breaking-up of old pasture or virgin soil, the cable-ploughing system is unrivalled, both for the thoroughness and rapidity with which the work may be performed. The power which can be applied to the ploughing tackle, whether the usual steam ploughing engines or the more-recently introduced motor engines are used, is so great compared with that exerted by horses or by any form of tractor, that special ploughs have naturally been developed for the system, and the illustration above shows the latest type of four-furrow anti-balance plough constructed by Messrs. Fowler. We mentioned this plough in our recent account of the agricultural exhibits at the British Empire Exhibition at Wembley (page 382 *ante*), but by an unfortunate slip it was attributed to another manufacturer.

The plough in question is arranged to cut four furrows 14 in. wide and from 8 to 12 in. deep. It has exceptional clearances under the frame and between the bodies to permit the free passage of rubbish, &c., which may exist on the land surface. It is fitted with the Fowler anti-balance gear which automatically allows the centre-carriage of the plough to move ahead, after the machine is tipped for its reverse passage. This causes a greater weight to come on to the working end of the plough, ensuring that it keeps down to its work when being pulled at a high speed. The advantages of the increased weight on the end of the plough at work, are not gained at the expense of more difficult reversing at headlands. The machine is reversed as easily as a balanced plough. Furthermore the amount of out-of-balance which occurs when the plough is working can be regulated, or the anti-balance gear can be put out of operation if desired, and the machine operated as a balanced plough. The whole implement is constructed almost exclusively of steel, and embodies the great experience of the makers in connection with such details as steering gear, mould-boards, shares, &c.

Messrs. Fowler and Company make an almost innumerable variety of ploughs for cable work as they specialise in this class of apparatus and supply tackle to meet the conditions required for any country or crop in the world. Their vine and heath ploughs are constructed for ploughing up to 24 inches deep and subsoiling up to 8 in. deeper. Ploughs for less drastic work are built to cut up to 10 furrows at a time. The makers also construct combined implements for preparing land previous to sowing, cultivation, rolling and harrowing all being performed by one passage of the implement. Scoops for excavating reservoirs, &c., trenching and ditching machines, land levellers and grades, and mole draining machines are also among the special implements which can be supplied to work in conjunction with cable ploughing engines.

THE SHIPBUILDING INDUSTRY.

The latest survey of the world position with regard to shipbuilding, embodied in Lloyd's Register issued for the quarter ended September 30, records little improvement abroad with regard to the industry, while in this country a setback has been sustained. Compared with the report for the preceding quarter the total merchant tonnage under construction in Great Britain and Ireland, 1,468,408, is substantially the same when allowance is made for the fact that the figure given for June included some 52,000 tons on which work had been suspended. The important figure which serves as an index by which the state of trade can be most easily estimated, however—the amount of new tonnage laid down during the quarter—shows a decrease of 122,000 tons when compared with the corresponding figure for the preceding three months. The launchings during the period under review are not quite 2 per cent. below the total for the earlier quarter. This year's wage increases to labour have intensified foreign competition by preventing us reducing quotations below present prices, and the recent order for oil tankers from the "Shell" Company placed abroad, is an example of how the course of future business may be affected.

The corresponding tonnage for France, 137,210, shows a decline of over 5 per cent. on the preceding return, while that for Japan shows a decrease of 25 per cent. from the 66,654 tons previously recorded. Dutch figures have decreased from 88,643 tons by over 8 per cent. Denmark, Norway and Sweden have registered increases, however, of 15 per cent. on 64,225 tons, 6 per cent. on 27,445 tons and 8 per cent. on 63,800 tons respectively.

The total number of merchant vessels under construction in the world amounts at present to 737, having a tonnage of 2,581,016. This compares with 2,616,897 tons for 786 vessels, the figures returned for last quarter, and apparently shows a decrease, but it is to be remembered that for the first time for a number of years no mention is made in Lloyd's Register of suspended tonnage, a handicap at one time amounting to over a quarter of a million tons and which was reduced to 52,000 tons at the end of June. In all probability, therefore, the present returns do not actually indicate a decrease.

The popularity of the motorship continues to increase. The world figures over the last three months shows motor ships equal to 57 per cent. of the steam tonnage. For the preceding period the figure was 45 per cent. and for the corresponding period a year ago only 24 per cent. In this connection it is interesting to note that of the combined tonnage building in Germany, Denmark and Sweden, motor vessels amount to 78 per cent. of the total. It may be argued from these figures that we in this country are not paying sufficient attention to this class of ship, our motor vessels under construction during last quarter only amounting to 26 per cent. of our steamers, but it is to be recollected that since we build more ships than the rest of the world combined it is more correct to base any estimation of the success of the motorship on figures issued for our own country than for returns of foreign nations. The enthusiasm of Germany, Sweden and Denmark is very probably due as much to their coal fuel situation as to any particular preference for the oil engine.

In the case of the large vessels 20 of the 35 now building in the world between 10,000 tons and 20,000 tons are being constructed in Britain, and the eight above 20,000 tons are all building in this country. In concluding, it should be pointed out that vessels below 100 tons are not included in these returns.

New Dutch Warship Construction.—The new Dutch cruiser Java, which was designed for service in the East Indies, has now been completed, and is running her trials off the Scottish coast. She was laid down in 1916; her sister ship, the Sumatra, will be completed next year. Her characteristics are: displacement, 6,930 tons; length, 509 ft.; beam, 52 ft.; draught, 18 ft.; indicated horse-power, 65,000; speed, 30 knots; radius of action at economical speed, 5,000 miles: armament, ten 5-in. and four 3-in. (anti-aircraft) guns. The cruiser is fitted as a minelayer and carries no torpedo tubes. She has a 3-in. armour belt covering nearly four-fifths of her total length. Her complement is 30 officers and 450 men.

London Iron and Steel Exchanges.—The report issued for the week ending September 30 by the London Iron and Steel Exchange, Limited, 123, Cannon-street, London, E.C.4, states that British works have had slightly improved requests for material for export. This however is seasonal buying and not sufficient permanently to affect the market. Home and Far Eastern markets have remained lifeless. The prices of Continental material have developed fresh weakness, efforts by foreign manufacturers to sell in the British market, however, meet with very little success. In the semi-finished section the Continental manufacturers continue to quote prices well below those of the British producers. The finished steel department is still inactive, while the pig iron position is unchanged.

OIL-ENGINED *versus* STEAM-DRIVEN TUGS.

THE growing practice of equipping vessels with internal combustion engines for the purpose of propulsion is not confined to large ships and designers are giving their attention to the construction of small craft so fitted. For example, two tugs, the Hurghada and the Safaja recently constructed by Messrs. J. Samuel White and Company, Limited, of Cowes, for the Egyptian Ports and Lighthouses Administration, are provided with six-cylinder Vickers-Petter heavy oil engines. The principal dimensions of the boats are :—length overall, 75 ft. length between perpendiculars, 70 ft.; moulded breadth, 20 ft.; moulded depth, 10 ft.; and mean draft, 8½ ft. A general view of the Hurghada is shown in Fig. 1. The vessel has a straight stem and counter-stern, the former being well cut up, while openings are provided in the deadwood aft to give good manœuvring qualities. Teak sheathing over the steel main deck prevents the latter becoming too hot in hot weather. Accommodation is provided below the forward deck for the captain and the engineer, the crews' quarters being situated beneath the aft deck. The oil fuel is carried in a cross bunker, of 16 tons capacity, at the fore end of the motor room, the latter occupying a position towards the stern of the tug. Air spaces between the bunker and the deck and sides of the vessel prevent undue heating of the fuel by contact with metal, heated by the sun's rays. Two strong towing hooks are fitted over the motor room casing just abaft amidships. A powerful hand-steering gear is fitted in shelter—seen mounted forward of the funnel in Fig. 1—which operates a balanced rudder.

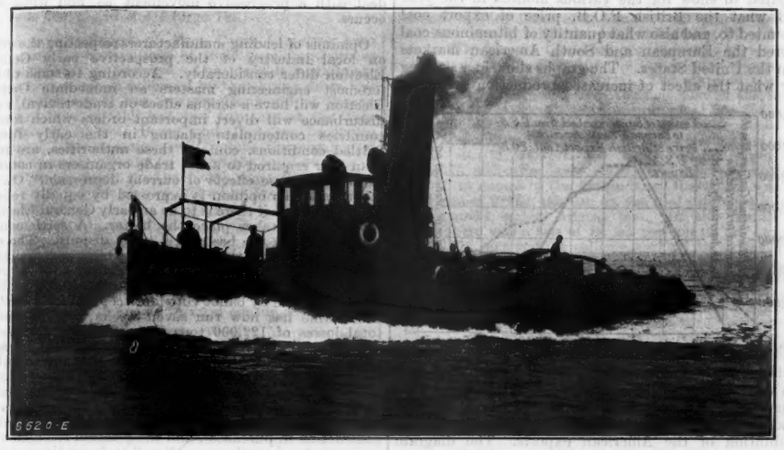
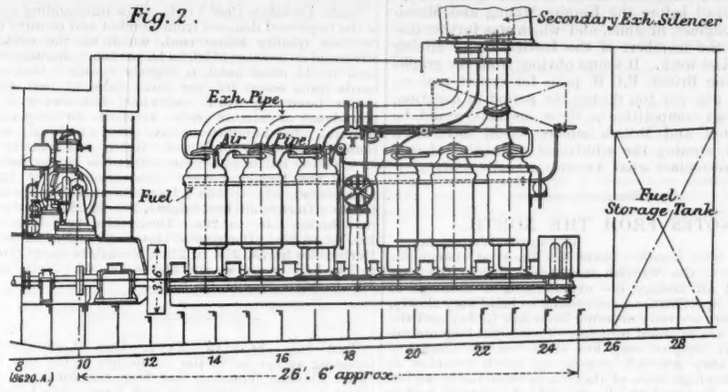
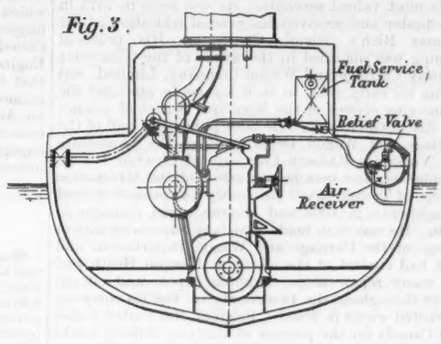
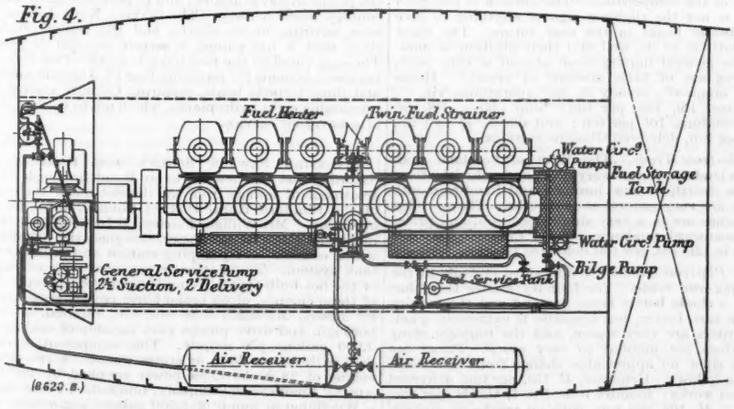
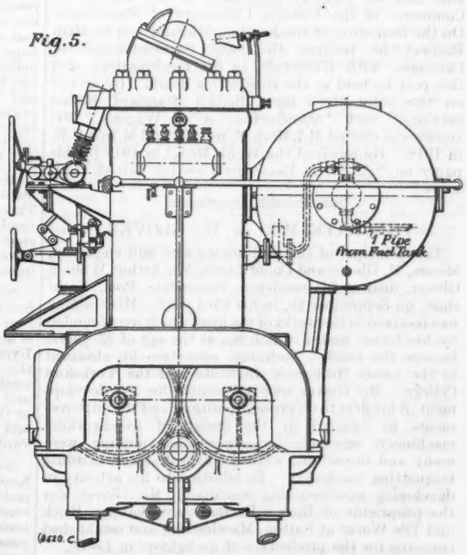


FIG. 1. THE MOTOR TUG "HURGHADA."









It is interesting to note that in the first instance designs were prepared for both motor and steam tugs of equal power. The dimensions of the vessels were the same, but the displacement of the motor-tug was two-thirds that required for the steamer, while the space occupied by the machinery and fuel was practically the same. The mileage that would be run by the motor tug on the fuel carried was about three times that for the steam ship. The total weight of motor machinery and auxiliaries was only about one-half of the weight of the steam machinery. In the cases of the steam and oil-fitted vessels the relative horse-power was 560 indicated horse-power to 450 shaft horse-power, the engine room length 38 ft. to 31½ ft., the weight of engine and boiler 72 tons to weight of oil engines with auxiliaries, shafting and exhaust piping 39 tons. The shaft horse-power per ton of machinery was 6·6 in the case of the steamer, compared with 11·5 for the oil ship. The bunker capacity of 20 tons of coal exceeded in weight the 19 tons oil fuel carried, but the coal consumption of 0·4 tons per hour compared with an oil consumption of 0·107 tons per hour meant a cruising range of 180 hours as against 50 hours in favour of the oil-fueled vessel. Further, the steam engined tug's crew comprised two engineers and one stoker, while that of the oil tug consisted of only two engineers.

The propelling machinery of the Hurghada is directly reversible, and has a nominal brake horse-power of 450 at 250 r.p.m., the six cylinders having a diameter of 16 in. and a stroke of 18 in. Fig. 2 shows the position of the engine in the vessel, the fuel storage tank, the exhaust pipe and the secondary exhaust silencer. The fuel feed pipe forms a hand-rail. The 39-in. flywheel is shown coupled to the Michell thrust block, the propeller being four-bladed and made of cast-iron. The disposition of the fuel service tank, relief valve, and air receiver are shown in Fig. 3. The engine is controlled by means of a handwheel and fuel lever, arranged midway between the cylinders. (See Fig. 4.) Four vertical plunger type pumps are placed at the forward end, three for circulating water and one for bilge, driven by reduction gearing at a speed of 90 r.p.m.

Each cylinder is complete with a water-cooled silencer mounted at the back. The auxiliary set consists of a Vickers-Petter oil engine of 13½ brake horse-power, having a single cylinder 8½ in. diameter, 9 in. stroke, running at 400 r.p.m., and directly coupled to a two-stage air compressor on the port side. This engine, shown in Figs. 3 and 4, also drives, through a clutch and gearing, a double-acting bilge and general service pump on the starboard side. The compressor has a capacity of 35½ cub. ft. of free air per minute compressed to a pressure of 200 lb. per square inch, charging two large starting air containers on the starboard side. A hand compressor and auxiliary air container are also mounted on the auxiliary engine platform. The general service pump is capable of dealing with 12 tons

of sea water per hour. The engine is controlled by means of a handwheel and fuel lever, arranged between the cylinders as shown in Figs. 5 to 7, on pages 517 and 520.

Electric light is fitted throughout, the generating set consisting of a Capel paraffin motor of 3½ brake horse-power, with petrol starting, driving a 1½-kw. generator. During the trials carried out on the test bed each installation took full load for six hours, afterwards running at reduced speeds, varying from 54 to 60 r.p.m., exceptionally even running being obtained. Reversing tests proved the engines to be capable of changing from ahead to astern in four to five seconds. By means of pressure-fed rapid starting blow lamps, the engine can be started from cold in two or three minutes. On a four hours' official trial a speed of 10·82 knots was obtained with a fuel consumption of about 31 gallons per hour.

The Hurghada arrived at Alexandria on June 7, and was dry-docked preparatory to speed trials. The Acceptance Committee of the Ports and Lights Authorities witnessed the trials, a speed of 11·1 knots being obtained. One such test was the coupling up of the Hurghada with the twin screw tug Tir-el-Mina. This ship is steam driven and develops 600 indicated horse-power at 160 r.p.m. Both vessels were placed stern to stern and set going at full speed ahead. For the first three minutes the steamer moved the Hurghada astern, but during the succeeding three minutes both ships were stationary. Finally, the oil-engined vessel steadily towed the Tir-el-Mina at a speed of 3 knots against the latter's own power.

THE LATE MR. F. E. GOBEY.

By the sudden death at the Railway Works, Derby, of Mr. Francis Edward Gobey on October 2, the London, Midland and Scottish Railway has lost one of its most valued servants. He was born in 1873 in Manchester and received his general education at Sir Thomas Rich's School, Gloucester. His practical training was obtained in the works of the Gloucester Railway Carriage and Wagon Company, Limited, and during his early years in their service he attended the engineering classes of the Municipal School of Science and Art in Gloucester. He later joined the staff of the Carriage and Wagon Department of the Lancashire and Yorkshire Railway Company at Newton Heath, Manchester, and became a student of the Manchester College of Technology. Mr. Gobey was promoted chief draughtsman in 1903 and became works manager in 1909. He was then made Assistant Superintendent in charge of the Carriage and Wagon Department, and thus had control of the works at Newton Heath and the many repair shops, cleaning depots and oil gas works throughout the two counties. For his company he visited works in France, Belgium, the United States and Canada for the purpose of studying railway works methods. He was lecturer on Rail-Carriage and Wagon Construction in the College of Technology, Manchester, and also on Railway Economics in the Faculty of Commerce of the Victoria University of Manchester. On the formation of the London, Midland and Scottish Railway he became Divisional Superintendent of Carriages, with Wolverton as his headquarters, and this post he held at the time of his death. He served on the committees for "British Standard Rolled Sections" and "Standardisation of Wagons." Mr. Gobey was elected M.I.Mech.E. in 1908 and M.Inst.C.E. in 1918. He received the Webb Medal in 1919 for his paper on "All-Metal Passenger Cars for British Railways."

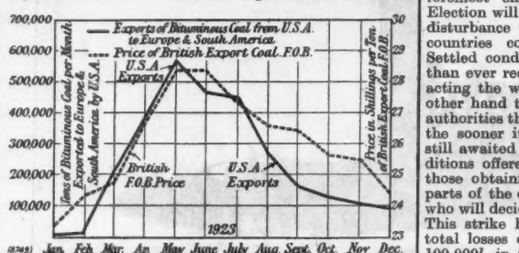
THE LATE MR. A. W. GLOVER.

The principal of the well-known saw mill engineers, Messrs. M. Glover and Co. of Leeds, Mr. Arthur William Glover, died at his residence, Riversdale, Pool, Yorkshire, on September 29, in his 63rd year. His training was received in the works of the firm, which were founded by his father and of which he, at the age of 23 years, became the head. Technical education he obtained in the Leeds Mechanics' Institute and the Yorkshire College. Mr. Glover was responsible for the development of his firm to its present position, and the improvements he effected in the design of woodworking machinery, especially for sawing and splitting, were many and important, while he also designed sawdust briquetting machinery. In addition to his activity in developing wood-working machinery, Mr. Glover was the proprietor of Bury's Earthenware Pottery, Brick and Tile Works at Sutton, Macclesfield, and established concerns for the production of firelighters in Leeds.

Society of Glass Technology.—The Journal of the Society of Glass Technology has now been published for the quarter ending September, 1924, by the Society at a price of 10*s.* 6*d.* net, and contains, besides the papers read, which were referred to in our columns at the various times they were read, a classified list of abstracts of papers dealing with various sections of the industry.

THE EFFECT OF BRITISH COAL PRICES ON THE AMERICAN EXPORT COAL TRADE.

American coal is a factor in the markets of Europe and South America which British producers have to consider. As the British prices rise and fall the American trade in what were British coal markets fluctuates in a way which is closely associated with the British price. The accompanying figure has been prepared to show for the various months in the year 1923 what the British F.O.B. price of export coal amounted to, and also what quantity of bituminous coal entered the European and South American markets from the United States. The graphs show in a striking way what the effect of increased production costs are.



As the British price rose the American trade increased in a way showing the close association of the two factors. When prices fell, nervousness of what might be the condition in the immediate future caused a more rapid diminution of the American exports. The diagram is based on figures quoted by Mr. Evan Williams, the President of the Mining Association of Great Britain, in a paper on "Economics of the Coal Mining Industry," which he read before the Empire Mining and Metallurgical Congress, in June, and which was further discussed by the members of the Institution of Mining Engineers last week. It seems obvious from the graphs that had the British F.O.B. price for export coal remained at 23*s.* per ton during the period in question, no American competition in these markets would be contemplated, and British miners would have been engaged in winning the additional quantities of coal necessary to replace what America actually sent.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Scottish Steel Trade.—There has been no change for the better in the Scottish steel trade during the past week, and all makers are experiencing a shortage of business. Specifications are coming to hand very slowly, as consumers are only ordering from day to day and the quantities are of small tonnage. Continental agents are active, but, despite very low offers for all classes of material, they are not picking up much business at present, although some of them have done fairly well in recent months, and the local works have been feeling the effects of the competition. The outlook is not good and there is not the slightest sign of anything to give hope for better times in the near future. The sheet makers continue to do well and their position is unaltered. The general inquiry from abroad is very poor, and exports are of little account at present. Home prices are nominally steady at last quotations, viz.:—Boiler plates, 13*l.* 10*s.* per ton; ship plates, 10*l.* 5*s.* per ton; sections, 10*l.* per ton; and sheets, ⅛ to ¼ in., 12*l.* 10*s.* per ton, delivered Glasgow stations.

Malleable-Iron Trade.—The West of Scotland malleable-iron trade continues very quiet and unsatisfactory. There is a dearth of new business and hand-to-mouth conditions are very general at the works. The re-rolled steel branches are in a very similar position, and prices have a downward tendency. For "Crown" bars the quotation is 12*l.* 10*s.* per ton delivered Glasgow stations.

Scottish Pig-Iron Trade.—A dull state prevails in the Scottish pig-iron trade. For foundry grades there has been just a shade better home demand and the inquiry is also the turn better, but hematite is extremely quiet. Export orders are very scarce, and the tonnage going through does not amount to very much. Prices are weak but show no appreciable change from last week, and are as follow:—Hematite, 4*l.* 15*s.* per ton, delivered at the steel works; foundry iron, No. 1, 4*l.* 15*s.* per ton, and No. 3, 4*l.* 10*s.* per ton, both on trucks at makers' yards.

Scottish Pig-Iron Shipments.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, October 4, amounted to 1,249 tons. Of that total 1,054 tons went overseas and 195 tons coastwise. For the corresponding week of last year the figures were 829 tons to foreign ports and 35 tons coastwise, making a total shipment of 864 tons.

The Iron and Steel Institute.—The first volume of the Journal of the Iron and Steel Institute for the year 1924 has now been published, and contains valuable notes on the progress of the home and foreign iron and steel industries, as well as the papers lately read before the Institute and already dealt with in Engineering.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—It is difficult to determine whether business in the bulk is progressing or retarding. Local unemployment remains much about the same as for the past month, with an occasional slight addition or diminution according to seasonal effects on individual trades. The winter outlook is regarded with a certain measure of anxiety, though comfort is drawn from the fact that all the staple trades of the district are well equipped to deal with a progressive movement as and when this occurs.

Opinions of leading manufacturers respecting the effect on local industry of the prospective early General Election differ considerably. According to some of the foremost engineering masters an immediate General Election will have a serious effect on trade revival, as its disturbance will divert important orders which foreign countries contemplate placing in the early future. Settled conditions, contend these authorities, are more than ever required to assist trade organisers in counteracting the worse effects of current depression. On the other hand the opinion is expressed by equally reliable authorities that if there is to be an early General Election, the sooner it takes place the better. A settlement is still awaited in the basic steel trade dispute. The conditions offered by the employers, which are similar to those obtaining in comparable establishments in other parts of the country are to be placed before the strikers, who will decide by ballot vote for acceptance or rejection. This strike has now run seven weeks and has caused total losses of 122,000 tons in output and close upon 100,000*l.* in wages. There is little movement in semi-finished materials despite the attractive prices ruling. Buyers generally are awaiting more settled conditions before placing contracts to cover forward commitments. The special trades are patchy. A slight revival in the best tool steels has been followed by a similarly slight contraction in purchases, and the position remains much as it was two months ago. Small tools continue a fairly active market. Building trade requirements are a feature.

South Yorkshire Coal Trade.—The outstanding feature is the improved demand from London and country users for best quality house coal, which on the week has advanced an average of 9*d.* to 1*s.* per ton. Manufacturing fuel, on the other hand, is slightly weaker. Best steam hards have eased 9*d.* per ton. Sales of best quality slacks have improved somewhat, but owing to the abundance of inferior grades available for open market disposal, official quotations have eased a shilling. Smalls remains nominally unaltered. Business in foundry coke is anything but brisk, recent reductions having failed to tempt the largest buyers. Quotations. Best branch handpicked, 32*s.* to 35*s.*; Barnsley best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 26*s.* to 28*s.*; Derbyshire best house, 24*s.* to 26*s.*; Derbyshire best large nuts, 22*s.* 6*d.* to 25*s.*; Derbyshire best small nuts, 14*s.* to 16*s.*; Derbyshire hards, 21*s.* to 23*s.*; Yorkshire hards, 21*s.* 6*d.* to 23*s.* 6*d.*; Rough slacks, 11*s.* to 13*s.* 6*d.*; Nutty slacks, 10*s.* to 12*s.*; Smalls, 6*s.* to 8*s.*

The Jugo Slavian Navy.—One of the most interesting symptons in the public life of the new Serbo Croat Slovene Kingdom has been the consistent effort which a group of influential men have made to interest the public in naval affairs; and to persuade them that the country needs a navy. The Serbian Navy League has been untiring in its efforts, and the recent estimates show that it has gained a certain amount of ground. The sum voted to the new navy is small—£286,000—but provision is made for repairing four ex-Austrian monitors and three torpedo boats, repairing Cattaro arsenal, and purchasing eight hydroplanes, which are to be the nucleus of a naval air service.

Riverside Sewage Scheme for Romford.—On Saturday last the new works at Rainham Creek for the treatment of sewage from the district under the control of the Romford Rural District Council, were put into operation. Mr. William Fairley, M.Inst.C.E., of Parliament Mansions, Westminster, designed the installation, which consists of a pumping station and sedimentation tank system. The station is provided with oil engines of the hot-bulb type, driving Worthington pumps. Two of these engines, of 50 brake horse-power, were supplied by Messrs. Marshall, Sons and Co., Limited, of Gainsborough, and drive pumps each capable of dealing with 3,000 gallons per minute. This equipment serves to deal with excess flows or storm water. A two-cylinder engine of 28 brake horse-power supplied by the Hamworthy Engineering Company, Limited, of Poole, driving a Worthington pump of 1,500 gallons per minute capacity meets the normal requirements. Another item of the equipment is a 14 b.h.p. Hamworthy oil engine driving a Broom and Wade air compressor to give supplies for operating sludge ejectors and for engine starting purposes. This engine also drives a 5 kw. Crompton dynamo for lighting purposes. The sewage is delivered by the pumps to the concrete sedimentation tanks through conical shaped depositing tanks. There are in the present installation four tanks, 100 ft. long and 30 ft. wide, but there is ample space available for large extensions. Storage of the effluent is necessary at certain states of the tide, and two large concrete tanks have been installed for the purpose. No filters have so far, been provided, as the river at the point of entry of the effluent is tidal, and the capacity of the available sedimentation tankage is such that no further treatment is at present considered necessary by the authorities.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Supply of Cleveland pig iron for the open market is not large, but demand is very quiet and prices are quite easy. Makers' stocks are stated to be fully disposed of, but customers are still failing to take up anything like their full purchases under contracts, and consequently the statistical situation does not improve. No. 1, though very scarce, is obtainable at 85*s.*; No. 3 g.m.b. is on sale at 80*s.*; No. 4 foundry is 79*s.*; and No. 4 forge 78*s.*

Hematite.—Producers of East Coast hematite have heavy unsold accumulations at their yards, and stocks continue steadily to improve. Considerable curtailment of output, however, is promised by the closing down this week of a furnace at the Newport Ironworks of Messrs. Samuelson, and by the last two furnaces at the Tees Ironworks of Messrs. Pease and Partners becoming inoperative. These actions will reduce the number of hematite furnaces blowing to 11 and the total number of furnaces in operation on the North East Coast to 39. Nos. 1, 2 and 3 hematite are offered at 88*s.* and No. 1 is quoted 88*s.* 6*d.*

Foreign Ore.—There is very little doing in foreign ore, and quotations are easier. Sellers base market quotations on best rubio at 21*s.* 3*d.* c.i.f. Tees.

Blastfurnace Coke.—Durham blastfurnace coke is in only very moderate request, and good average qualities are on sale at 25*s.* delivered to local consumers.

Manufactured Iron and Steel.—Foreign competition in manufactured iron and steel continues keen. Continental firms are still selling semi-finished steel here at prices well below quotations for local products. Prices here are weak but hardly quotably lowered. Producers' figures stand: Common iron bars, 12*l.* 10*s.*; packing (parallel), 9*l.*; packing (tapered), 12*l.*; iron rivets, 14*l.* 5*s.*; steel billets (soft) 8*l.* 10*s.*; steel billets (medium) 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel rivets, 14*l.* 15*s.*; steel boiler plates, 13*l.* 10*s.*; steel ship, bridge and tank plates, 10*l.* 5*s.*; steel angles, 10*l.*; steel joists, 10*l.*; heavy sections of steel rails, 9*l.*; fish plates, 13*l.*; and galvanised corrugated sheets (24 in. gauge, in bundles), 18*l.* 10*s.*

Imports of Iron and Steel.—Monthly returns of the Tees Conservancy Commissioners issued this week give the imports of iron and steel to the River Tees from Holland, Belgium, France, Norway, Sweden, Germany, India and coastwise for the eleven months ending September, 1924, together with those for the same months a year ago, and for the corresponding pre-war period of 1913–14. Pig iron brought in to the end of last month amounted to 21,868 tons, as against 12,843 tons a year ago, 1,427 tons for the pre-war period; crude sheet bars, blooms, billets and slabs unloaded to the end of last month reached 84,887 tons, as against 66,526 tons a year ago and 33,655 tons in the pre-war period; and plates, bars, angles, rails, sheets and joists imported to the end of last month totalled 18,457 tons, as against 10,482 tons a year ago and 19,481 tons in the pre-war period.

Shipments of Iron and Steel.—Last month's shipments of iron and steel from the Tees ports amounted to 75,122 tons—31,989 tons pig iron, 5,165 tons manufactured iron, and 37,968 tons steel. Of the pig iron despatched 17,841 tons went to foreign destinations, and 14,148 tons went coastwise; of the manufactured iron cleared 1,849 tons went to foreign destinations, and 3,316 tons went coastwise; and of the steel shipped 28,705 tons went to foreign destinations, and 9,263 tons coastwise. The largest receivers of pig iron were: Scotland, 10,020 tons; Belgium, 3,500 tons; Wales, 2,770 tons; Denmark, 2,712 tons; Italy, 2,130 tons; Germany, 2,045 tons; France, 1,935 tons; Sweden, 1,100 tons; and New South Wales, 1,020 tons. Nova Scotia, with an import of 843 tons, was the best customer for manufactured iron. Principal receivers of steel were India, 9,933 tons; New South Wales, 3,644 tons; Victoria, 2,903 tons; Japan, 1,750 tons; Natal, 1,475 tons; and Hong Kong, 1,065 tons.

MERCHANT SHIPPING LOSSES.—According to statistics just issued by Lloyd's Register of Shipping, the world's losses of merchant shipping during the quarter ended March 31 last, amounted to 161,201 gross tons comprised in 105 vessels. Great Britain and Ireland lost 22 ships, totalling 38,949 tons, during the period, but the latter is only 0·2 per cent. of the total tonnage owned in this country. In the case of the United States, the losses amounted to 32,108 tons (17 ships), the proportion of the total American tonnage lost being 0·22 per cent. Japan lost 0·64 per cent. of her merchant tonnage during the quarter under review, the losses including seven vessels with an aggregate tonnage of 22,999. For Italy the losses amounted to 13,011 tons, or 0·43 per cent. of the total tonnages and the corresponding figures for Germany and France respectively were 2,817 (0·11 per cent.) and 7,457 (0·20 per cent.). In proportion the heaviest losses during the quarter were suffered by Greece, the 5,213-ton vessel lost by that country, amounting to 0·69 per cent. of the total Greek tonnage. In this connection it is noteworthy that Greece appears to hold the position of greatest sufferer in these lists frequently. The above-mentioned figures include steamers, motor ships and sailing vessels of 100 gross tons and upwards, but the totals exclude cases of breaking-up, condemnation, &c., which are not known to be consequent upon stress of weather, &c. If such cases are included, the total losses for the whole world amount to 519,608 tons, comprised in 239 vessels.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—The general position of the Welsh coal trade is practically unchanged. New business continues insufficient to absorb available supplies notwithstanding the loss in production occasioned by the closing down of collieries. The result is that prices generally are entirely a question of individual bargaining with values controlled by the circumstances of each buyer and seller. For the same quality coal prices differ by 1*s.* to 2*s.* per ton according to the different circumstances. Steam large and small of all grades are in abundant supply with the best Admiralty large from 27*s.* to 27*s.* 6*d.* and the other grades from 23*s.* to 26*s.*, while smalls range from 10*s.* for the inferior classes up to 15*s.* for the very best sorts. The state of the industry may be gathered from the fact that in the three months ended August 1 total output at 11,354,668 tons was 2,300,000 tons less than the quantity produced in the corresponding period of 1913 while the cost of production at 11,239,327*l.*, of which wages absorbed 7,568,427*l.* and other costs 3,670,900*l.*, was no less than 471,291*l.* in excess of the proceeds, so that there was an actual loss of 9·96*d.* per ton on the coal produced in the three months ended August last. In the month of August there was a loss of 1*s.* 3*d.* per ton on the output of 3,531,916 tons and the colliery workers wages has been certified at 16·08 per cent. on the 1915 standard compared with 20·72 per cent. in July. The wages payable this month, based on the August returns, however, remain at the minimum of 42·22 per cent. on the 1915 standard, and to pay this the owners are compelled to sacrifice the whole of their standard and surplus profits. Production was 400,000 tons less than in August of last year, and the cost of production was 1*s.* per ton higher than in July while the average pit-head selling price was reduced by about 2*d.* per ton. The new wages agreement it is estimated has added 1*s.* 5*d.* to 3*s.* 1*d.* per ton to the cost of production.

Iron and Steel.—Exports of iron and steel goods last week amounted to 21,152 tons compared with only 8,591 tons in the preceding week. Those of tinplates and ternplates totalled 12,589 tons against 4,695 tons, blackplates and sheets to 4,615 tons against 2,101 tons, galvanised sheets to 2,630 tons against 990 tons and other iron and steel goods to 1,318 tons against 779 tons.

A METHOD OF MINIMISING STREET NOISES.—The Holborn Borough Council are having the part of High Holborn opposite the Holborn Restaurant surfaced by a new method in an effort to minimise traffic noises. The granite setts will remain in position and will be covered with a top layer of bituminous material 1¼ in. thick, made of bitumen, dry rock asphalte, limestone, sand, cement and other ingredients not specified.

EXPORT TRADE WITH CHINA.—Mr. H. H. FOX, the commercial counsellor at the British Legation, Peking, who is at present on leave in this country, will be in attendance at the Department of Overseas Trade from October 20 to October 31 inclusive, for the purpose of interviewing British manufacturers and merchants interested in export trade with China. Such interviews will only be given by appointment and all applications, quoting the reference 5494/T.G., should be addressed to the Comptroller-General, Department of Overseas Trade, 35, Old Queen-street, Westminster, S.W.1.

BRITISH COMMERCIAL GAS ASSOCIATION.—The 13th annual conference of the British Commercial Gas Association was opened at Liverpool on Monday, September 29, and the meetings were continued until Wednesday, October 1. In his presidential address Mr. H. Wade Deacon, chairman of directors of the Liverpool Gas Company, referred to the necessity for cheap power if any country was to maintain its position in trade against foreign competition. In a country where there was not an abundance of available water power and no oil wells, he said, coal had to be used in the most efficient way. Although electricity might be the means largely, but not entirely, adopted to obtain power without the production of smoke, gas and coke must be regarded as the fuels most suited to obtaining heat without polluting the atmosphere. Discussions were later held on "Gas as an Aid to Health," under four sectional headings.

THE INSTITUTION OF CIVIL ENGINEERS.—The Council of the Institution of Civil Engineers have made the following awards in respect of selected engineering papers, published without discussion during the session 1923–24: A Telford Gold Medal to Mr. E. H. Lamb, D.S.O., M.Sc., Assoc.M.Inst.C.E. (London); Telford and Indian Premiums to Mr. F. C. Temple, M.Inst.C.E. (Jamshedpur, India); and Telford Premiums to Mr. H. A. Lewis-Dale, M.B.E., M.Inst.C.E. (London); Professor Louis N. G. Filon, D.Sc., F.R.S. (London) and Mr. C. J. Gyde, M.Inst.C.E. (Pretoria). In respect of papers read at students' meetings in London, or by students before meetings of local associations, they have also awarded the James Forrest Medal, the James Prescott Joule Medal and a Miller prize to Mr. R. W. Mountain, B.Sc., Stud.Inst.C.E. (London); and Miller prizes to Messrs. H. S. Smith, B.Sc., Stud.Inst.C.E. (London) and C. D. Crosthwaite, B.Sc., Stud.Inst.C.E. (London); H. C. Toy, B.Sc., Stud.Inst.C.E. (Birmingham); F.W. S. Hawtayne, B.Sc., Assoc.M.Inst.C.E. (London); E. G. Wilson, Stud. Inst.C.E. (North Shields); and W. W. Davies, B.Sc., Stud.Inst.C.E. (London).

NOTICES OF MEETINGS.

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night at 7.30 p.m. at 39, Victoria-street, S.W.1. Ordinary meeting. "The Design of Static Sub-stations, with Some Notes on their Equipment," by Mr. N. Thornton. Friday, October 17, at 7.30 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C.2. Special meeting. Lecture, "High Voltage Electric Oscillations," by Mr. R. P. Howgrave-Graham. M.I.E.E.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND METALLURGY.—Saturday, October 11, at 2 p.m., in the Lecture Theatre of the Institute, Newcastle-on-Tyne. Inaugural Address by the President. Further discussion on "Safety Lamps Giving Warning of Gas," by Dr. W. M. Thornton. "The Heat due to Strata Movement and its Effects on Certain Coal-Seams," by Professor Henry Briggs, Ph.D., D.Sc., A. L. S. Owen and John Wilson, "The Washing of Fine Coal by the Froth-Flotation and Concentrating-Table Processes at Oughterside Colliery, Cumberland," by Messrs. J. G. Scouler, B.A., and Basil Dunglinson.

THE MINING INSTITUTE OF SCOTLAND.—Saturday, October 11, at 3 p.m., in the Heriot Watt College, Chambers-street, Edinburgh. Discussion on "Boring in Frozen Strata," by Mr. Robert L. A. Dron, B.Sc. "Some Uses for Hydraulic Stowing," by Mr. Richard Kirkby. "Some Problems of Indian Coal Mining," by Professor David Penman, D.Sc. "Problems of Mechanical Coal Mining," by Mr. Sam Mavor. Papers to be read:—"Experiments on the Flow of Air in Mines," by Professor David Penman, D.Sc. "Efficiency of Safety Lamps," by Mr. James Cooper, F.R.S.E., and Mr. D. Davidson.

THE KEIGHLEY ASSOCIATION OF ENGINEERS.—Saturday, October 11, at 6.30 p.m., Assembly Room Cycling Club, Cavendish-street, Keighley. Lecture: "Keighley Waterworks," by Mr. M. Ratcliffe Barnett, M.Inst.C.E.

THE INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Monday, October 13, at 7.30 p.m., at the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow: Chairman's Address. Also some notes on "Brass Foundry Casting," by Mr. John Stirling.

THE INSTITUTION OF MECHANICAL ENGINEERS: SOUTH WALES BRANCH.—Tuesday, October 14, at 6 p.m., at the Chamber of Commerce, Swansea. Chairman's Address by Mr. J. W. Burr.

THE SOCIÉTÉ DES INGENIEURS CIVILS DE FRANCE.—BRITISH SECTION.—Tuesday, October 14, at 6 p.m.. at the Institution of Mechanical Engineers, Storey's Gate, S.W.1: "Repairing and Strengthening of Cast-Iron Railway Viaducts by the Use of Reinforced Concrete and Arc Welding," by Monsieur de Boulongue.

THE INSTITUTE OF MARINE ENGINEERS.—Tuesday, October 14, at 6.30 p.m., at 85-88, The Minories, Tower-hill, E.1. Discussion on "Indicator Diagrams and Lessons Therefrom."

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Tuesday, October 14, at 7 p.m., at Caxton Hall, Westminster, S.W.1. "Safety Valves," by Mr. H. A. Stirzaker.

THE INSTITUTE OF BRITISH FOUNDRYMEN—LANCASHIRE BRANCH: BURNLEY SECTION.—Tuesday, October 14, at 7.15 p.m., at the Municipal College, Burnley. Open discussion on "Some Foundry Problems."

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Tuesday, October 14, at 8 p.m., at the Royal Automobile Club, Pall Mall, S.W.1. Presidential address by Dr. W. R. Ormandy on "Research."

THE SOCIETY OF GLASS TECHNOLOGY.—Wednesday, October 15, at 3 p.m., in the Applied Science Department, The University, St. George's-square, Sheffield: "The Present Position of the Glass Industry in North America," by Professor W. E. S. Turner, D.Sc.

THE ROYAL METEOROLOGICAL SOCIETY.—Wednesday, October 15, at 5 p.m., at 49, Cromwell-road, South Kensington, S.W.7: "The Brown Corona and the Diameters of Particles," by Mr. Lewis F. Richardson, B.A.; "Photometric Observations on Clouds and Clear Skies," by Mr. Lewis F. Richardson, B.A.; "Notes on 'Habooks,'" by Mr. L. J. Sutton, M.A.

THE INSTITUTION OF MINING AND METALLURGY.—Thursday, October 16, at 5.30 p.m., at the Geological Society, Burlington House, Piccadilly, W.1: Discussion on "Hygrometry for Deep Mines," by Mr. J. S. Jones; "A Short History of the Discovery and Development of the Sullivan Mine: the Solution of its Difficult Metallurgical Problems; and a description of the Plants Used in the Reduction of its Ores," by Mr. W. M. Archibald and others; "A Research to Determine the Size of the Gold Particles in the Witwatersrand Banket Ores and their Rate of Solution in Cyanide," by Mr. K. L. Graham and Mr. F. Wartenweiler.

THE ROYAL AERONAUTICAL SOCIETY.—Thursday, October 16, at 5.30 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Large All-Metal Seaplanes," by Dr. Rohrbach.

THE NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, October 17, at 7.30 p.m. Annual General Meeting. Presidential address by Mr. Tom Westgarth.

THE INSTITUTION OF AERONAUTICAL ENGINEERS.—Friday, October 17, at 6.30 p.m., at the Engineers' Club, Coventry-street, W.1.: "Commercial Airship Design," by Commander F. L. M. Boothby, C.B.E.

TWO-STROKE HOT-BULB OIL ENGINE FOR EGYPTIAN GOVERNMENT TUG "HURGHADA."

CONSTRUCTED BY MESSRS. VICKERS-PETTERS, LIMITED, ENGINEERS, IPSWICH.

(*For Description, see Page* 517.)

Fig. 6.

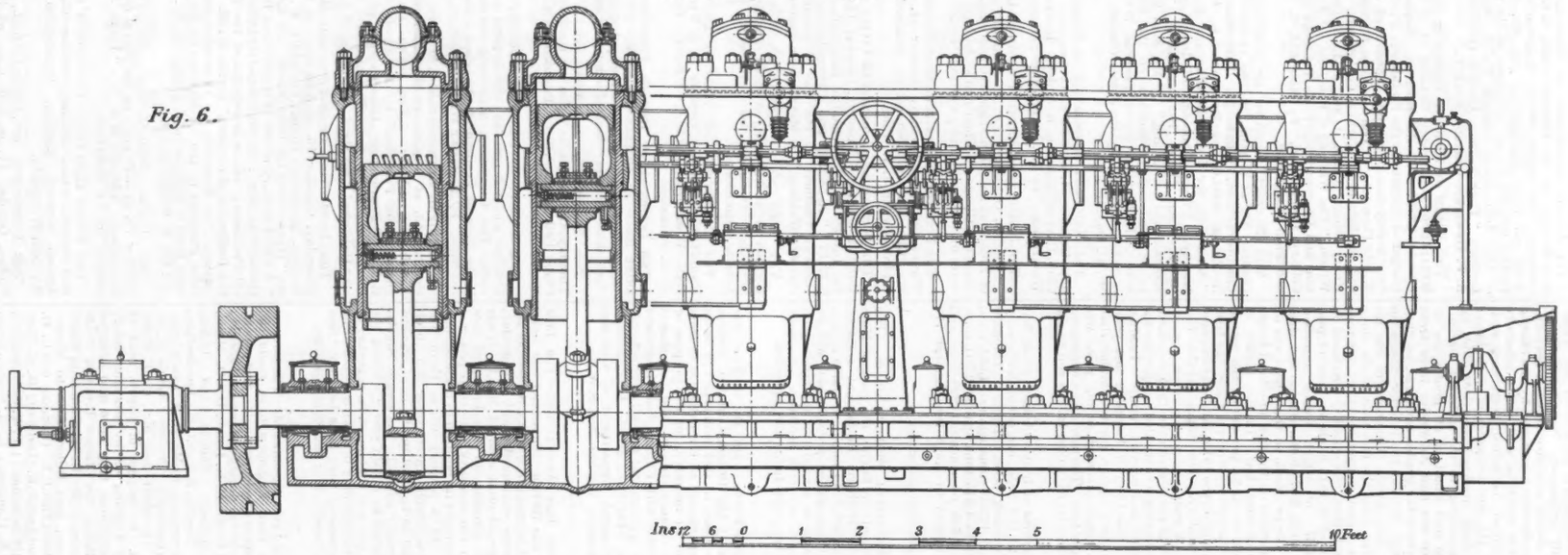
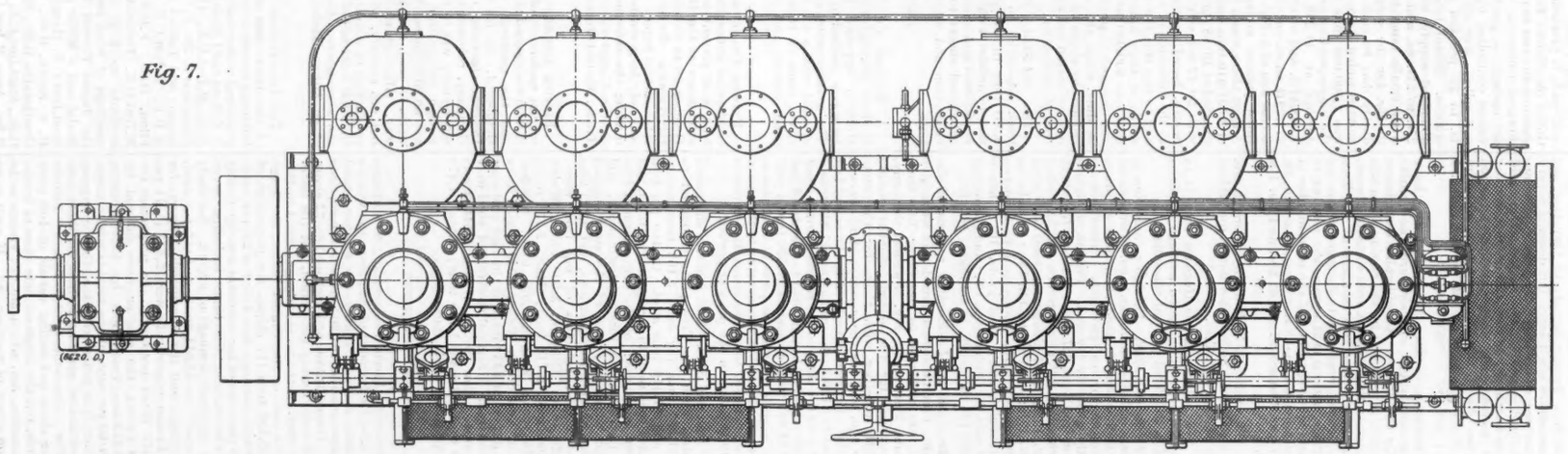


Fig. 7.



PERSONAL.—Messrs. Johnson and Phillips, Limited, electrical engineers and cable makers, Charlton, London, S.E.7, have removed their Cardiff branch offices and stores from 2a, Court-road, to 10, Westgate-street, Cardiff.—In future Messrs. F. R. Rand and Co., Limited, of 38, Victoria-street, London, S.W.1, will be designated Messrs. G. H. Sheffield and Co. (Engineers), Limited.—The Minister of Health has appointed Mr. J. R. Taylor to be an engineering inspector on the staff of the Ministry.—The offices of the Manchester Association of Engineers are now at 16, Albert-square, Manchester, and not, as formerly, at 120, Portland-street.

EXPORT TRADE WITH FRANCE.—Mr. J. R. Cahill, the Commercial Counsellor to H.M. Embassy in Paris, arrives in this country at an early date for the purpose of a short official visit. He will be in attendance at the Department of Overseas Trade from Monday, October 13, till Friday, October 17, inclusive, for the purpose of interviewing British manufacturers and merchants interested in export trade to France. Such interviews will only be given by appointment, and all applications quoting the reference No. 5445/T.G. should be addressed to the Comptroller General, Department of Overseas Trade, 35, Old Queen-street, Westminster.

PIE

PIETTE COKE OVENS AND ROBINS CONVEYOR; SHELTON IRONWORKS.

THE SEMET-SOLVAY AND PIETTE COKE OVEN COMPANY, LIMITED, SHEFFIELD.

(*For Description, see Page* 510.)

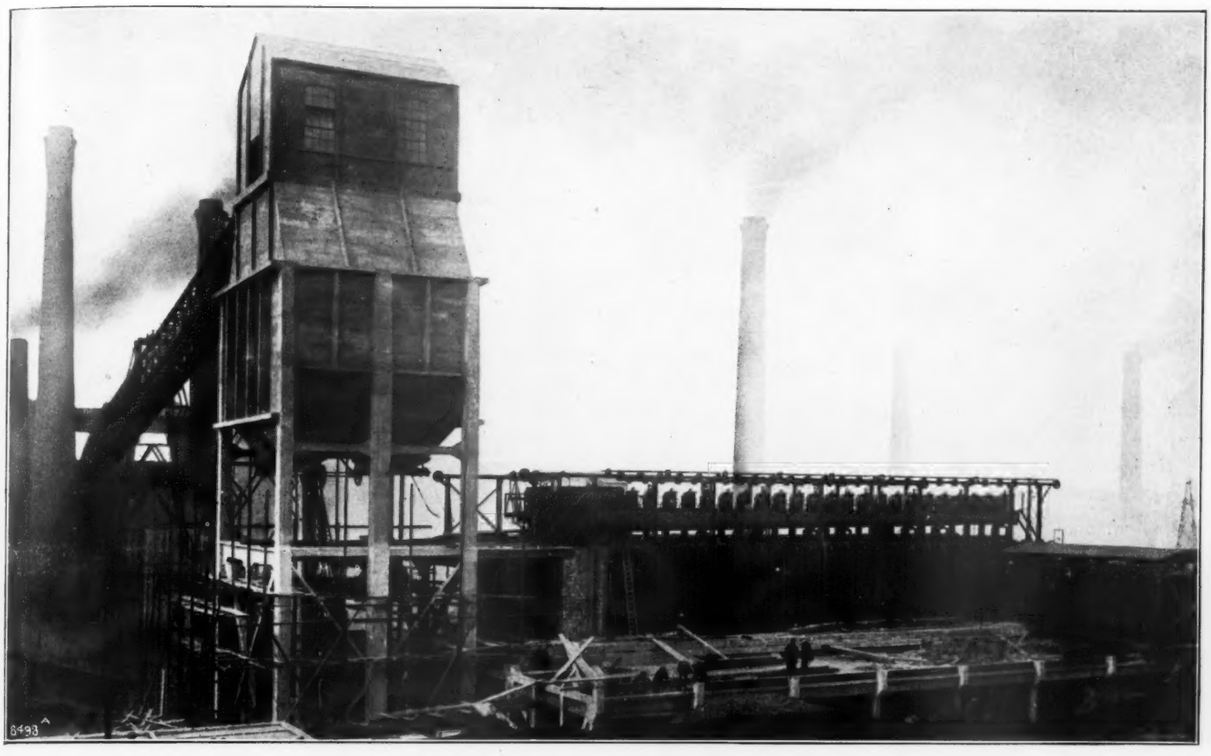


Fig. 8. View of Ovens and Coke Hearth.

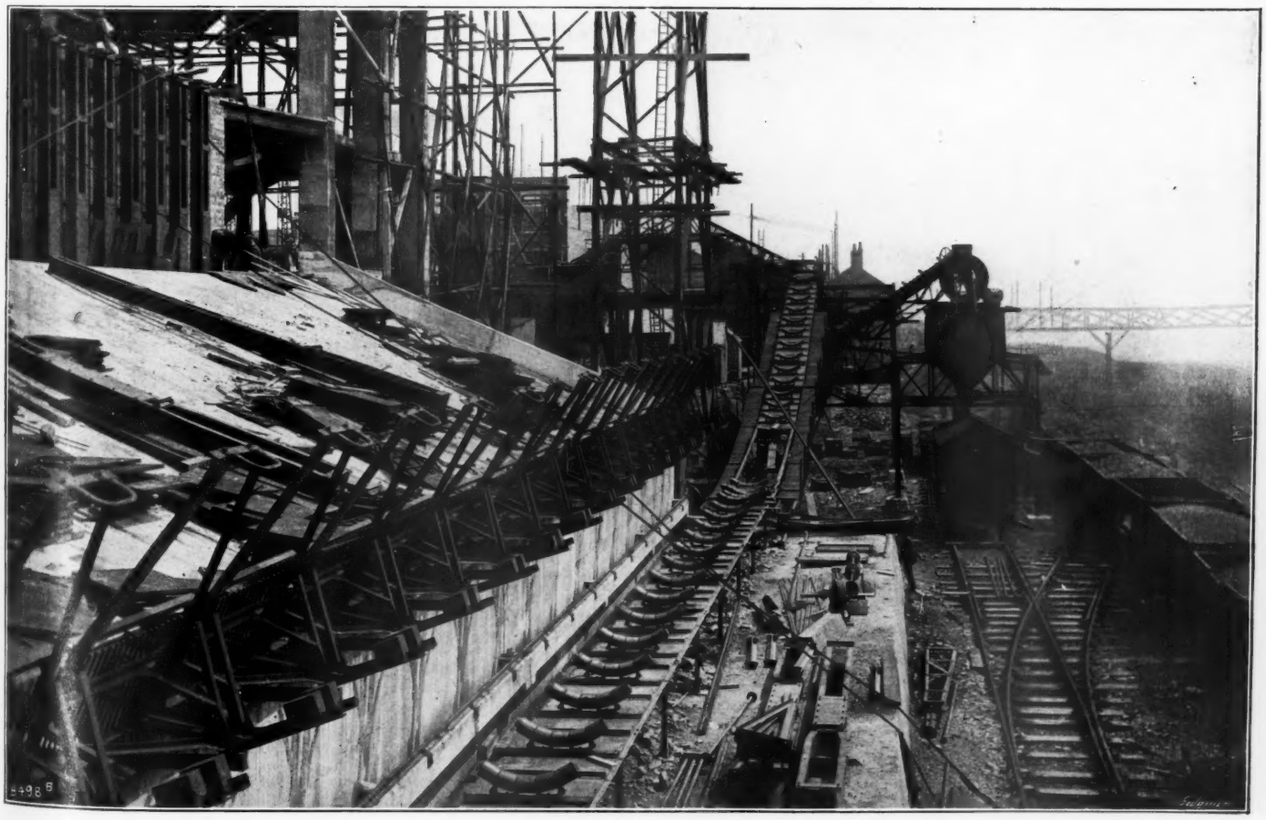


Fig. 9. Robins Conveyor.

(*To face page* 512.)

CHARGING MACHINE AND COKE OVENS AT THE SHELTON IRONWORKS.

THE SEMET-SOLVAY AND PIETTE COKE OVEN COMPANY, LIMITED, SHEFFIELD.

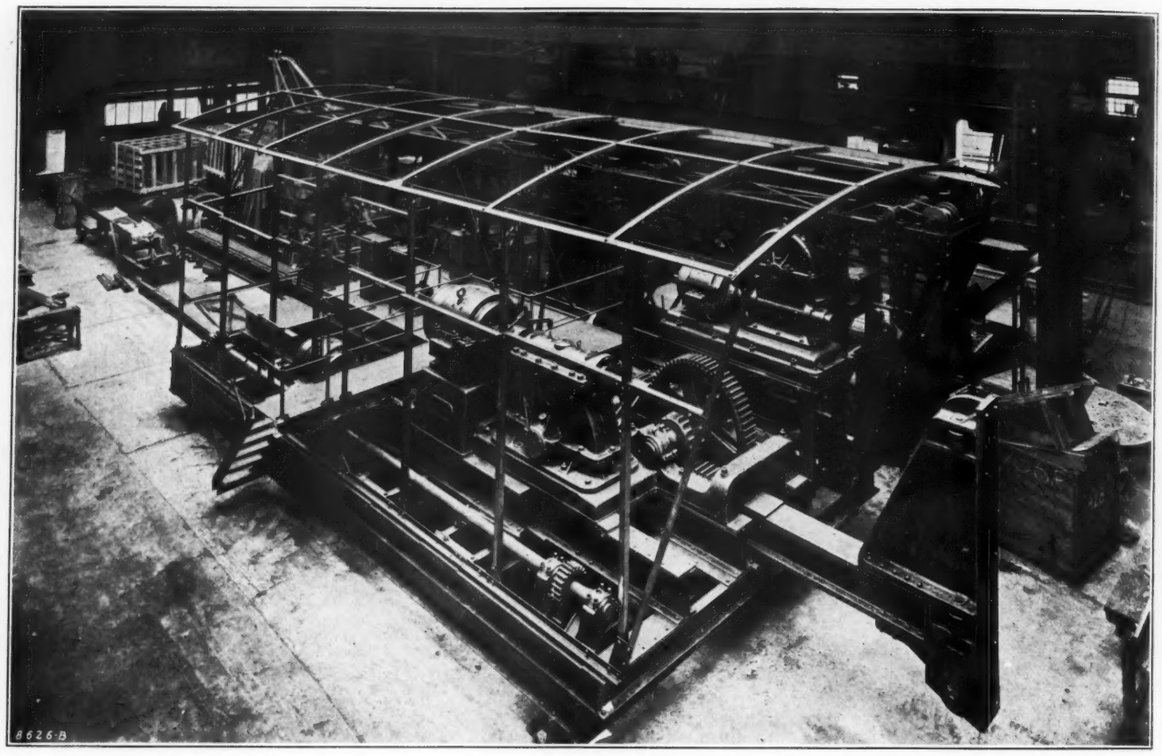


FIG. 10. CHARGING MACHINE; MESSRS. M. B. WILD AND CO., LIMITED, BIRMINGHAM.

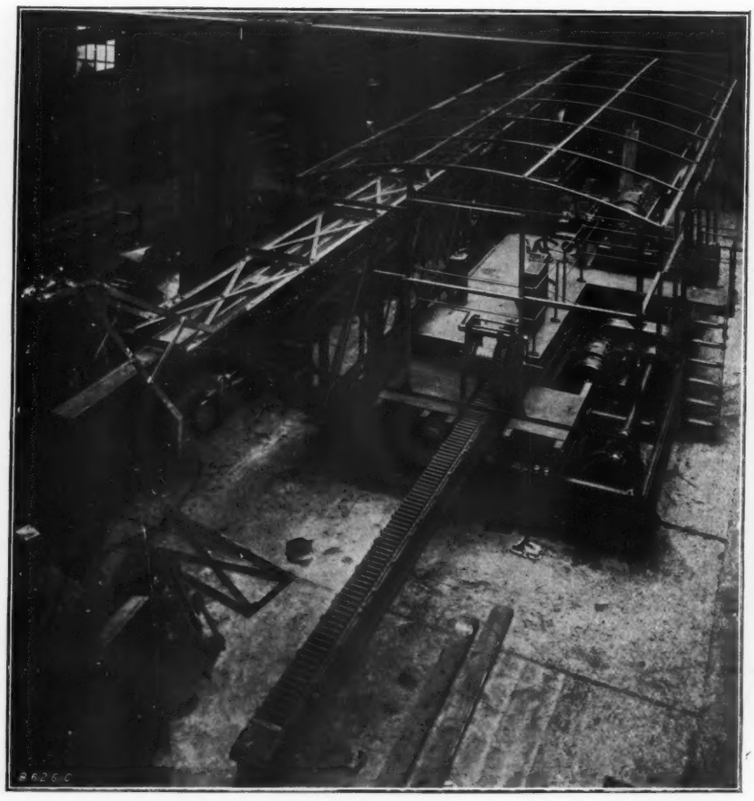


FIG. 11. CHARGING MACHINE; MESSRS. M. B. WILD AND CO.. LIMITED, BIRMINGHAM.

FIG. 12. OVEN FACE ON RAM SIDE.

(To face page 513.)

PALM-OIL EXTRACTING AND KERNEL-SEPARATING PLANT FOR NIGERIA; EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. MANLOVE, ALLIOTT AND CO., LIMITED, ENGINEERS, NOTTINGHAM.

(*For Description, see Page* 513.)

(*To face page* 514.)

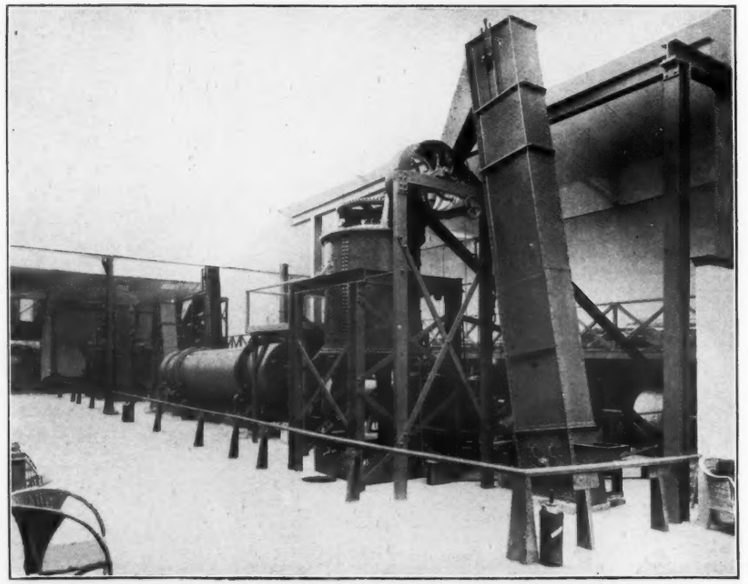


FIG. 3. VIEW OF COMPLETE PLANT FROM RECEIVING END.

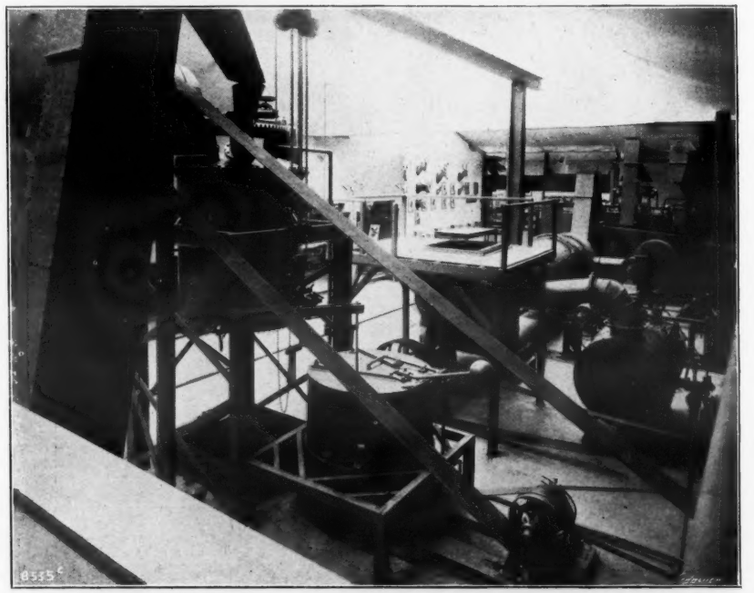


FIG. 4. VIEW OF DIGESTER AND CENTRIFUGAL SEPARATOR.

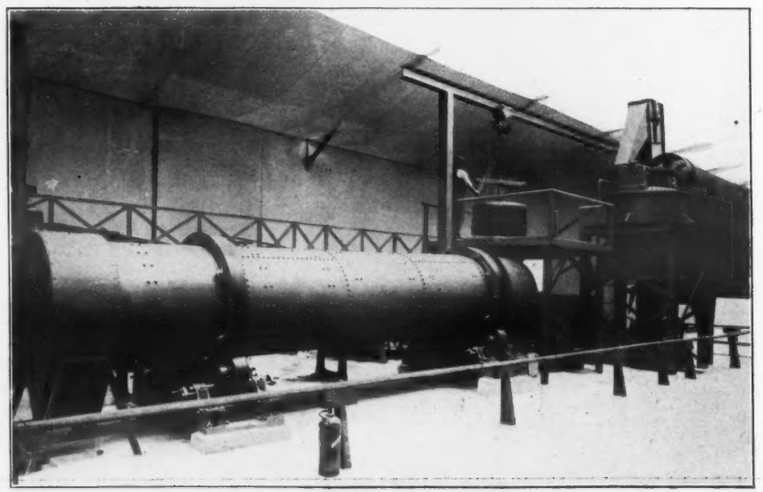


FIG. 5. FRONT VIEW OF ROTARY DRIER.

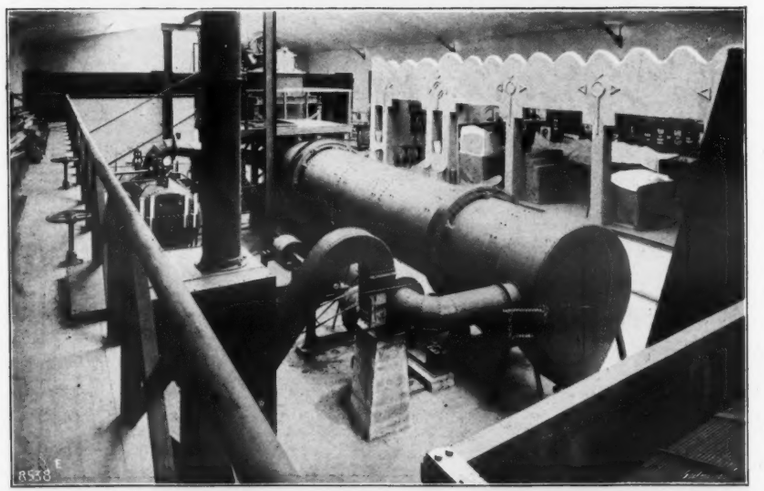


FIG. 6. REAR VIEW OF ROTARY DRIER, SHOWING EXHAUST FAN FOR FLUE GASES.

PALM-OIL EXTRACTING AND KERNEL-SEPARATING PLANT; BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. MANLOVE, ALLIOTT AND CO., LIMITED, ENGINEERS, NOTTINGHAM.

(*For Description, see Page* 513.)

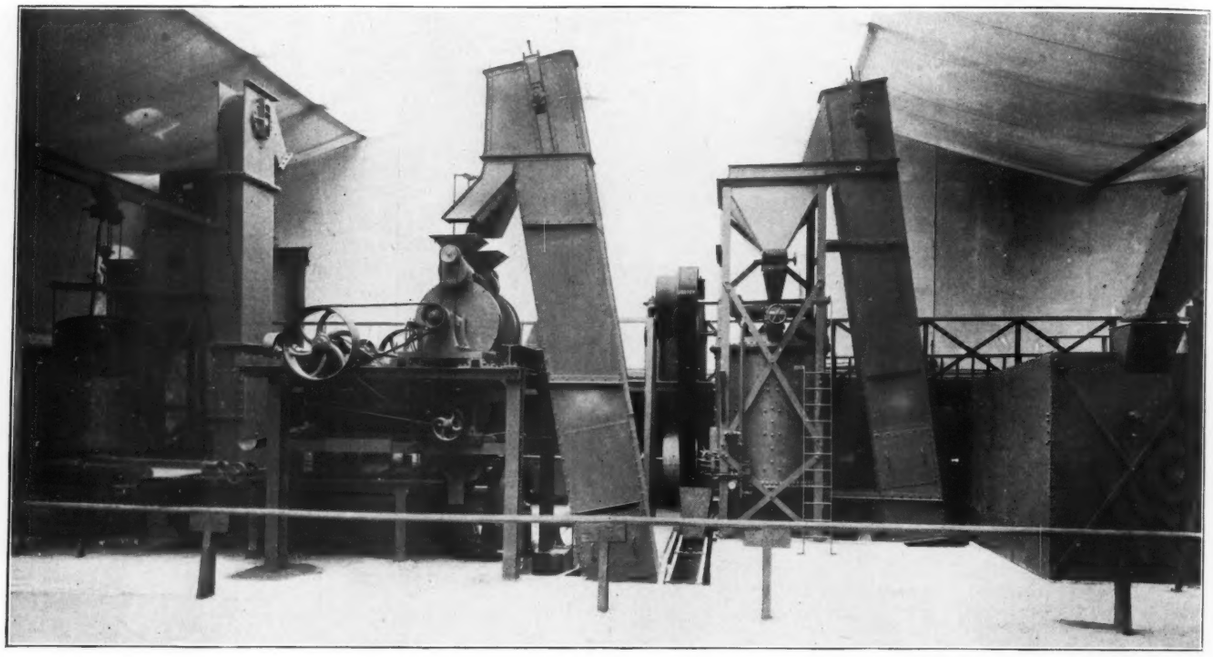


FIG. 7. GENERAL VIEW OF KERNEL-SEPARATING PLANT.

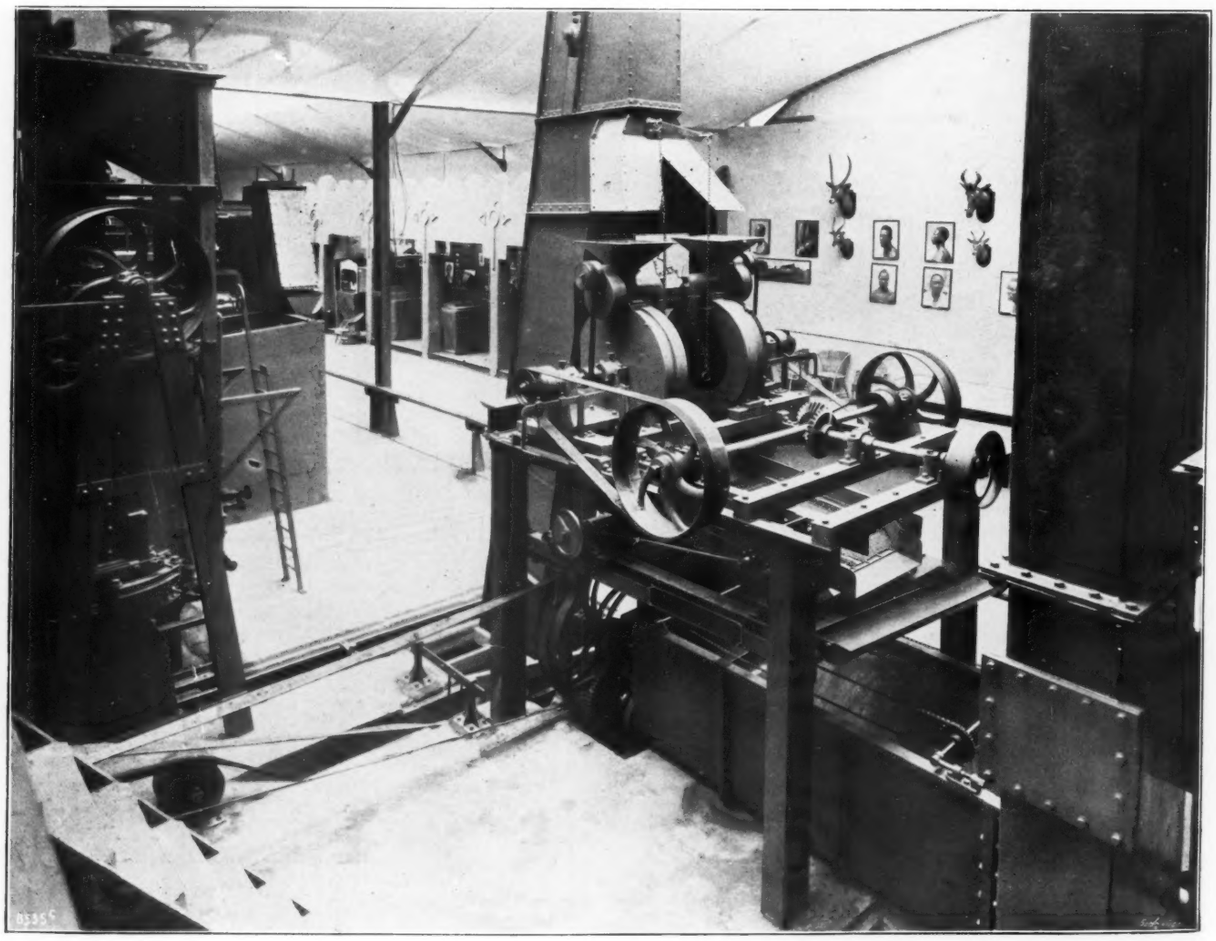


FIG. 8. NUT-CRACKING MACHINES AND KERNEL-SEPARATING TANK.

(*To face page* 515.)

ENGINEERING.

Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C.2.

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Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received 10 days previous to the day of publication.

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CONTENTS.

	PAGE
Horizontal Tacheometry (*Illus.*)	505
Canada and the British Association	506
India and Burma at the British Empire Exhibition (*Illus.*)	507
Notes on New Books	509
Piette Coke Ovens (*Illus.*)	510
Palm-Oil Extraction Plant (*Illus.*)	513
Microscopes for Metallographic Work (*Illus.*)	514
Four-Furrow Anti-Balance Plough (*Illus.*)	516
The Shipbuilding Industry	516
Oil-Engined *versus* Steam-Driven Tugs (*Illus.*)	517
The Late Mr. F. E. Gobey	518
The Late Mr. A. W. Glover	518
The Effect of British Coal Prices on the American Export Trade (*Illus.*)	518
Notes from South Yorkshire	518
Notes from the North	518
Notes from Cleveland and the Northern Counties	519
Notes from the South-West	519
Notices of Meetings	519
The Cost of Coal	521
The London Traffic Problem	522
Research in Industry	522
Recent Development in Oil Cracking	523
Notes	524
Literature	525
Books Received	525
Lympne Trials of Two-Seater Light Aeroplanes	525
Labour Notes	527
The Colliery at the British Empire Exhibition (*Illus.*)	528
Merryweather Fire Appliances at the British Empire Exhibition (*Illus.*)	530
The Effect of High Temperature on the Range of Repetition Stresses on Steel (*Illus.*)	532
Catalogues	534

Four One-Page Plates.—PIETTE COKE OVENS AND ROBINS CONVEYOR; SHELTON IRONWORKS. CHARGING MACHINE AND COKE OVENS AT THE SHELTON IRONWORKS. PALM-OIL EXTRACTING AND KERNEL SEPARATING PLANT FOR NIGERIA; BRITISH EMPIRE EXHIBITION.

ENGINEERING.

FRIDAY, OCTOBER 10, 1924.

THE COST OF COAL.

IN times of industrial depression, when many potential workers are idle, but supported by doles made available through the industry of others, it is advisable that a complete study be made of all the factors which prevent production at competitive prices. Goods can only be sold at the prices which the potential consumer can afford to pay, and unless they can be produced at costs which make this possible, the entire activity of the works concerned must immediately cease. Competition with other manufacturers, in our own or other countries, has the effect of determining from what sources the consumers will obtain his requirements, and thus the manufacturer has a maximum price fixed for him by conditions quite external to his own control. What can be done, however, is to reduce production costs by improvements in methods of working. Modern machinery may be installed, and the work done by each employee may become more specialised in the endeavour to keep down the item of costs. The cheapening of production is made a question difficult of solution by the attitude shown by the men as indicated in the output returns for each workman employed. While it is sometimes contended that there is no organised endeavour on the part of the men's leaders to restrict output, it cannot be denied that the results show that slackness is a prevailing condition among the workmen in some industries. This is the cause of dull trade and the enforced idleness of many who could otherwise be given employment. To cite coal as an example, figures were given by Mr. Evan Williams, the President of the Mining Association of Great Britain, in a paper on "Economics of the Coal Mining Industry," which he read before the Empire Mining and Metallurgical Congress in June, and which was discussed last week at the meetings of the Institution of Mining Engineers. These show that the output per worker per shift at the end of 1923 was only 17·97 hundredweights, compared with 20·3 hundredweights in 1913, a reduction of 11½ per cent.

Coal figures largely in the returns relating to exports from this country and the preservation of this trade is essential to the maintenance of our international trade balance on which the cost of food and indeed all living expenses, so largely depend. When conditions permit the exportation of American coal to Europe and South America, the American traders quickly grasp the opportunity and cut out the British supplies. An examination of the conditions which ensure the maintenance of the British position may be obtained from the monthly returns during the year 1923. As these figures are of great interest we have put them into the form of a graph which will be found in this issue of ENGINEERING on page 518. As the price of British export coal rises, the Americans enter the market, and it may be observed that the tonnage of the United States export trade in bituminous coal rises with the British price with a degree of exactitude which is quite remarkable. There is, too, a falling off in the American trade when the British price falls, which might be anticipated when it is remembered that then the position in the immediate future cannot be exactly gauged. During the period for which the diagram was prepared it seems obvious that had the British F.O.B. price been kept down to 23*s.* per ton the participation of America in these overseas markets would have been entirely, or almost entirely, prevented. One-third of our coal is sent abroad and it will be appreciated that if this export trade is to be maintained, the cost of production must be such that prices may be kept down to cut out competition. Granting concessions in prices to overseas users of coal would not meet the conditions for the heavy users of coal in this country are the iron and steel trades, which must have cheap coal if their output is to be sold in competition with that of foreign origin.

Nothing but a reduction in the cost of winning coal and in the railway transport charges can produce the desired effects. With cheap coal available, the production of all types of goods would become possible at competitive prices, and a great increase in employment and reduction of the cost of living would result. The elements making up the average price in 1923 of 19*s.* 11*d.* per ton at the pithead for the commercially disposable coal are: wages, 12*s.* 7¼*d.*; timber and stores, 2*s.* 3¾*d.*; other production costs, 3*s.* 6¼*d.*; and the remainder, after meeting costs which are not considered in the ascertainment of wages, is available as profit. Wages constitute two-thirds of the selling price of coal. The wages are determined on the results of the activity in a complete district and not on the returns of poor collieries, as is often alleged by some of the representatives of the workers. In the period during which the agreement on wages was in full operation—up to December, 1923—profits only amounted to 11·9 per cent. of the wages, or about two-thirds of what was contemplated in the agreement, because of the failure of the recoupment provisions, under which the owners might be recompensed for a loss by profits made in later periods. In 1923 an output of coal of 279 million tons was obtained at a wages cost of 155,000,000*l.*, whereas in 1913 the output was 287 million tons and the wages amounted to 91,000,000*l.* The eight-hour day for underground workmen which was in operation prior to 1919 gave an effective day of 6¼ hours at the coalface, the balance being occupied in walking to and from the face and in meal times. The reduction of one hour under the Act of 1919 reduced the working time to 5¼ hours and involved a reduction of 15 to 16 per cent. in actual working time. Recent investigation by an American Commission on the Coal Industry showed that the average actual working time of American colliers was 6 hours 54 minutes. In Westphalia the working hours have been increased to eight. In France and Belgium the 8-hour day is in operation. From this statement of working times it may be judged how this country is handicapped in meeting the

competition of foreign coal, and how our large industries are prevented from reducing the prices of their goods to figures comparable with those of foreign manufacture. When comparative output at different periods is under consideration, it must not be forgotten that the use of machinery and electric power in mining has grown extensively since 1913, but the output per man has decreased. New methods of working, new means of production have been introduced, and all have proved of no avail in increasing the yield per man and so reducing the cost.

Cheap coal is essential and the main item in its cost being wages, increased activity on the part of the workmen is imperative. Without an increase in the rate of production there can be no justification for reduction of hours. There seems to be no doubt that the lamentable condition of the mining industry is largely due to the slackness of the workers, who by their inaction are preventing the employment of their fellow miners, as well as restricting the activity of every industry in the country.

Suggestions are often made, particularly by laymen and enthusiastic inventors, that the conditions as regards output and costs in the coal industry will right themselves if full advantage is taken of modern scientific progress. The reference is mainly to the possibilities of extended low temperature carbonisation. Unfortunately those who speak optimistically on this matter do not appreciate the difficulties which still have to be contended with. Mr. Frank Hodges, the miners' leader, when addressing the Mining Students' Association at Wigan last Saturday, spoke of what might be done in this country in this respect in the future. Were the difficulties removed, much of the oil which we obtain from abroad could be produced at home, and thus assist in the maintenance of the international trade balance of our country.

When the time that this is entirely possible is reached, coal mining may be conducted under different conditions, owing to the fact that there may be a marked change in the relationship of imports and exports. Whatever is done, however, to reach the stage of complete carbonisation of our coal resources will depend on the prevailing economic conditions. We have a problem in coal production which cannot be left to solve itself in some far distant future. We have a problem which demands solution now. The winning of coal at prices which make it saleable is imperative, and until the output of coal per man is largely increased and the price reduced, there can be little hope of any material reduction in the general unemployment returns or of marked decreases in the cost of living.

THE LONDON TRAFFIC PROBLEM.

To what extent the population of Greater London will continue to increase must remain matter for speculation, but it is clear that there is as yet no sign of any check, and the difficulty of the concomitant traffic problem continues to grow. This problem we have inherited from the past, and it seems probable that we will pass it on to our children. In the year 1905, each inhabitant of Greater London made, on an average, 188 journeys in tram, train or omnibus. By 1923 this figure had risen to 421, and it will be clear that this figure does not represent the total increase of travel, since it takes no account of the great increase in the use of motor cars. The figures do not include long-distance, main-line train journeys into, or out of, London.

Although it is usual and in some ways convenient to consider street and railway traffic together in discussing this question, it is clear that the two are on a very different footing. Indeed, it may quite safely be said that the problem of London traffic as ordinarily understood, is concerned only with street traffic. There is a problem in connection with railway transport in the London area, but that is not how to deal with it, but how to make it pay. The total increase in railway traffic in the period taken above amounted to 60 per cent., but the total increase in tramway traffic amounted to 94 per cent., and in omnibus traffic to 288 per cent. These figures we quote from the presidential address which Sir Lynden Macassey delivered at the inaugural meeting of the session of the Institute of Transport on the 6th inst.

It does not appear that there would be any difficulty in dealing with a very great increase in railway traffic, if it were to come, by building new tubes, doubling some of those now in existence, and increasing the capacity of further suburban sections of the main line railway by electrification. One may indeed, expect work of this latter kind to assist in relieving the street pressure in a comparatively few years. The problem of London traffic, as we see it, is not one of railways at all. It appears to be to a considerable extent due to the increase of passengers who favour road above rail transport. Lord Ashfield has stated that the average speed of the vehicular traffic in the streets of Central London has fallen to-day to one-half of what it was in 1919, and it is clear that the great proportional increase in tram and omnibus traffic must be partly responsible.

One may reasonably assume that street transport is a greater convenience to the public than rail transport, otherwise the public would not patronise it to a greater extent. None the less if street transport throttles itself by its own growth, it is clear that it will cease to be a greater convenience to the public and they will forsake it for the railway. If such traffic is still increasing at a greater rate than rail transport, notwithstanding the fall in average speed quoted by Lord Ashfield, it is clear that we have not yet reached the point at which the railways are the more attractive. This question, however, is not one only concerning trains, omnibuses and trams. The growth in street traffic is interfering with business generally, and although the omnibus passenger, who has an alternative method of travel by tube which he does not use, has no serious grievance about the slowness of street traffic, other street users have.

Sir Lynden Macassey, in the address to which we have referred, suggests that the present difficulty in Central London may be assisted by decentralisation and the moving of large concerns to the outer suburbs. This would certainly help, but it is difficult to see that anything official can be usefully done in that matter. Again, if it is to the benefit of works and large administrative concerns to go to the suburbs, they will go. If it is not, they will stay where they are, and they can hardly be forced to go to new sites on which they would conduct their business less profitably or less efficiently. A fair amount of movement of this kind is already taking place naturally, and the only practicable procedure appears to be to let it continue to do so. Sir Lynden referred to the enormous cost of any attempts to deal with traffic congestion by street widening, and referred favourably to Lord Montagu's scheme for overhead roads to which he thought we would be driven at no distant date. It may be that it would be cheaper to construct an overhead roadway from Trafalgar Square to Temple Bar with proper means of access to it than to widen the Strand between these points, but it is really difficult to think so.

Sir Lynden Macassey suggested that possibly "heroic measures are justified." They may be, but something a little less heroic and to the ordinary man more sensible, might possibly have precedence. Part of the length of street we have mentioned is now being widened, and not far from the Hotel Cecil the road has been left for a short distance at its old width, forming a throttling point, and to a large extent nullifying the effect of the other widening. No doubt the leases of the property at this point have not fallen in, but leases can be bought, and if some heroism were displayed in dealing with obvious absurdities of this kind, the heroism of overhead Strands might be left to a distant future.

The whole question of London traffic is obscured and much mixed up with disputes between tramways and omnibuses, and between different omnibus authorities. According to Sir Lynden Macassey the average receipt per vehicle-mile does not greatly differ between train coaches, trams and omnibuses, but the railway cost of capital per mile of route is twenty times, and that of the tramway three or four times, that of the omnibus. These figures are sufficient to explain the great success of the omnibus in competition with the tram. The tram, of course, developed before the motor omnibus, and naturally all the capital invested in it simply cannot be written off, but it is clear that no case exists for any considerable increase in tramway mileage. Particularly is this the case anywhere near the centre of London, since the tramway interferes to a much greater extent with other traffic than does the omnibus. It is apparently fair to say that a tramway cannot be made to pay unless it is protected from motor-omnibus competition, and since the public patronises the omnibus in preference to the tram it evidently serves it better, so that public interest would be affected by eliminating such competition. Trams must certainly be put up with, since they exist and so much public money has been invested in them, but if the new London Traffic Committee makes any arrangements to restrict such competition it is to be hoped such restriction will always have in view the fact that the matter is one of expediency and not of traffic efficiency.

In the address to which we have more than once referred Sir Lynden spoke several times about a uniformity of fare basis in the London traffic area, and pointed out that such a uniformity could only be secured between railways, tramways and omnibuses by working them all as one and pooling the receipts. We are not absolutely clear what Sir Lynden means by a uniformity of fare basis, but if he means that a traveller in one of the remoter parts of Surrey should be carried for a mile for the same price as one in Holborn we cannot see that such a uniformity of fare basis has any justification. To subsidise transport in outlying areas at the expense of transport in the centre is not to the public benefit. It is not to the public benefit to run any services for less than they cost. The only effect of this is that other users or non-users are charged for something from which they receive no benefit. It is frequently stated that the London General Omnibus Company runs many outlying services at a loss, but if this is so, the purpose is to cultivate a traffic which it is calculated will ultimately pay. This is a reasonable commercial procedure.

In this connection it is claimed that the opposition omnibus companies put their vehicles on central busy routes and take the cream of the traffic. They naturally put them where they think they will obtain a paying load, and if they obtain such a load in the central area it merely shows that that area was not previously fully served. It is quite possible that these opposition companies are introducing a greater density of service than the demand warrants. In that case they are doing neither themselves nor anyone else any good, and some of the services must ultimately drop out. The fleet with the best vehicles, the longest purse and the best management is likely to survive. These are matters of every-day competition, but London street transport affects so many people who are not directly concerned with it that nothing but good is likely to come from its survey as a whole by a competent authority, and the appointment of the London and Home Counties Traffic Advisory Committee should lead to such a survey. The problem is one of such complexity that it may ultimately prove impossible to leave it to ordinary competitive development, and may prove necessary to introduce some common working scheme covering the whole area.

RESEARCH IN INDUSTRY.

Anyone turning to the recently issued ninth annual report of the Department of Scientific and Industrial Research in the hope of finding interesting stories of scientific discoveries made during the past year is doomed to disappointment. The report* which, with its appendices, runs to 139 pages, is an uninspiring document, giving a colourless summary of the work of the Department and of the various research organisations connected with it. The number of industrial research associations in actual operation is now 23 and an additional one is

* Report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1923–1924. Published by H.M. Stationery Office, London, Manchester, Cardiff and Edinburgh. Price 3s. net.

being started for the sugar industry. The grants to these associations during the year 1923–24 amounted to 103,187*l.*, and we gather that a further sum of 48,727*l.* was contributed to other researches. This money was provided from the 274,297*l.* granted by the Exchequer, but this did not nearly cover the total expenditure of the Department, which amounted to 515,382*l.* for the year. Much of this was, of course, derived from the interest and capital of the "Million Pound Fund" with which the Department was started. At the end of last March this fund stood at 618,318*l.* The estimated amount to be provided by Parliament for the current year is 328,281*l.*, which exceeds the estimate of 276,863*l.* for last year by 51,418*l.*, or by about 18 per cent. The receipts and expenditure of the Department for the year are not given anywhere in tabular form, so that analysis is not so easy as it otherwise would be.

By making an addition of some figures given in an appendix, we find that a total of 394,133*l.* had been granted up to date to the various industrial research associations. Two only of these, namely, the Photographic Research Association and the Scientific Instrument Research Association, have completed six years of work, and only four have completed five years of work. The largest amount received by any individual body has been 58,601*l.*, granted to the Glass Research Association in respect of four years of work. The Scientific Instrument Association have received 54,484*l.* for six years of work and the Cotton Industry Research Association have had 44,294*l.* for five years' work. Seven associations altogether, including those mentioned above, have received more than 20,000*l.* each. As it is an essential condition of receiving a grant that the industry concerned shall put up an equal amount, it will be seen that quite considerable sums are being expended in the effort to improve industrial processes and products.

The research associations more directly concerned with the engineering trades generally are those which have been formed to investigate questions dealing with cast iron, non-ferrous metals, Portland cement and refractories. The Iron Manufacturers' Research Association, which has been in existence for four years, has not yet received a grant from the Department. Of the more specialised associations connected with the engineering trades are those devoted to the interests of the electrical and allied industries, the motor industry and the cutlery trade.

We are given in the report no detailed information concerning the activities of any of the 23 industrial research associations which are in existence, or any account of the practical results achieved. It is stated, however, that full reviews have been made during the year of the work of the nine associations which have nearly or quite reached an age of five years. Each review was carried out by a visiting committee possessed of the requisite qualifications, and containing at least two persons of high scientific standing unconnected officially with the Department. From the evidence so obtained, the Department "has no hesitation in saying that the scheme as a whole has justified its inception," and they add that "a large part of the success achieved is due to the enlightened and enthusiastic guidance which has been freely given . . . by the leaders of the industries, in starting a new and untried movement." The visiting committees specially noted the attitude of the various associations to the question of undertaking consultative work for individual firms. In a few cases only they considered that the attention paid to work of this character was unduly great. The Department clearly recognises the difficulty of drawing a hard and fast line between what is legitimate for a State-aided Association to do in this matter and what is not, but it enunciates the sound general principle that the criterion of legitimacy should be whether the work is for the good of the Association as a whole. If it is, it should be performed without a fee, and the results communicated to all the members. Consultative work, if undertaken, in special cases for individual firms, should be placed upon a proper financial basis, and even then its extent thould be strictly limited.

The Portland Cement industry appears to be the only one which has yet got its research association upon such a basis that it can continue doing effective work without further State assistance. The Associations connected with the woollen, boot, scientific instrument, cotton, linen and cocoa trades are all to receive further grants of sums appropriate to their needs. Only in two cases is there adverse comment, the fault in one instance being administrative and in the other technical. The former relates to wastefulness of funds, but unfortunately the erring Association is not specified. Nor do the Committee indicate any action that they have taken or could take to enforce economy. They recommend, however, that a standard form of accounts should be adopted by all the Associations to enable the expenditure upon research and administration to be compared upon a reliable basis. This, we think, should certainly be insisted on. The other complaint of the Committee is in reference to the Glass Research Association. They are not "favourably impressed with the scientific results achieved," and, furthermore, consider that "the present financial position of the industry affords no prospect that the firms will be prepared to subscribe funds sufficient to justify the continuance of a research Association for this trade." This is a poor report on an industry which has already received 58,600*l.* of public money for research, and one fears that the secretive policy associated with the trade may be primarily responsible both for the failure of its research Association and for its unfortunate financial position.

Although only one-fifth of the total expenditure of the department is used to assist the various trade research associations, we think that this fraction is likely to be more productive of practical results than much of the remainder. It seems optimistic, for example, to hope for anything useful from "an investigation into problems of machine design in relation to the comfort and efficiency of the operator" for which a grant, of unspecified amount, has been made. The investigating body are the Medical Research Council whose innocence of any knowledge of machinery and its functions is to be counteracted by expert assistance. In such a case as this, the public, who after all find the money, should be assured that there is anything to find out more than every machine maker and user knows already, that the Medical Research Council is competent to pass an opinion on machine design, and how much money is being granted to them.

It is, we venture to say, a great defect of the report under review that no information is given in respect of the expenditure on the researches, other than those of the various trade associations. In connection with the Fuel Research Board, for example we are told only that "a sum of 20,000*l.* to 30,000*l.* per annum, in addition to the present expenditure of the Board would be fully justified" for various further work. The report is silent as to what the present annual expenditure is, or how much has been spent since the work was started. Among the objects of the Board is a "Physical and Chemical Survey of the National Coal Resources." This is being done by Committees, of which two are in operation. In the Lancashire and Cheshire area, the result of over two years' work is that the examination of five seams is "practically complete so far as laboratory work is concerned." The other committee is "making good progress" with its first seam. At this rate it is to be feared that some of the seams will be worked out before the investigators get to them.

It is in connection with the various methods of the carbonisation of coal that the Fuel Research Board is probably doing the best work, and we are glad to note that it proposes in future to issue an annual report of its activities. Arrangements have now been made for the Department to undertake tests on low temperature carbonisation plants for private parties, an enterprise which we thoroughly commend. If the scheme could be enlarged so as to include steam-boiler tests it would be even more advantageous. There is pressing need for some independent body, possessing the proper men and apparatus, to do for boiler users, what the National Physical Laboratory will do for users of gauges, thermometers, &c., namely, to make a proper and authoritative test beyond which there would be no appeal. We do not know any way in which the Department could earn the gratitude and appreciation of coal users more quickly than by extending its testing work in the direction we have indicated.

RECENT DEVELOPMENT IN OIL CRACKING.

The distillation of oil, crude or refined, is always accompanied by partial decomposition, even when performed at atmospheric pressure and when superheating is avoided. That is one of the chief reasons why the nature of natural oils remains obscure. Distillation at higher pressures is more destructive, and the kinetics of this pyrolysis are still but little understood, even when we start from simple hydrocarbons. The destructive distillation of oil for the purpose of breaking down high-molecular complexes into compounds of lower molecular weight and of higher value is technically known as cracking. The cracking may be performed in the vapour phase or in the liquid phase. In vapour-phase processes, the oil is vaporised, and the vapours are passed through reaction vessels heated to high temperatures, generally in the presence of catalysts, although the hot iron walls themselves act as catalysts. In liquid-phase processes, the pressure in the vessels is maintained sufficiently high to keep the oil substantially in the liquid state. The materials are therefore different to start with in the two processes. But more depends upon the working conditions than upon the raw material; there will always be vapours, and the vapour-phase and liquid-phase processes can be no more rigorously distinguished, than we can speak historically of vapour-phase and liquid-phase periods. The two processes have developed simultaneously, but the liquid phase predominates at present. In 1923, nearly 21 per cent. of the gasoline used in the United States was produced by cracking, mainly in the liquid phase, and the art of cracking is now being standardised, as Messrs. A. E. Dunstan and R. Pilkethley stated in a paper on "Recent Development in the Art of Cracking," read before the Institution of Petroleum Technologists last Tuesday.

Vapour-phase processes, working practically at atmospheric pressure, it will be conceded to Dr. Dunstan, have not been particularly successful. The losses are high, and the products are poor in quality and apt to gum on standing, though that tendency can be suppressed. High-pressure processes, on the other hand, are still in the experimental stage, and the preference is for moderate pressures. Dr. Dunstan has observed that the quality of the products changed but little as the pressure was raised from 350 lb. to 700 lb. per square inch. If it were possible, each separate compound should be cracked at the temperature at which decomposition sets in; when that temperature was gradually exceeded, however, the quantity of spirit obtained was almost doubled by every further increase of 10 deg. C.—an interesting observation in accordance with the general rule of the rate of chemical reactions. The analogy went further; the same increase in the spirit contents was noted when the rate of pumping was halved or the reaction time was doubled; there would then be a definite relation between the three variables, time, temperature and yield. The suitable adjustment of these variables in technical plants is more a matter for the engineer than for the chemist; in that sense the engineer has a greater share in the progress of cracking than the chemist, as is generally the case in industrial chemistry. The two have, of course, to co-operate, for instance, with respect to the undesirable deposition of coke during the cracking. That deposition cannot altogether be avoided; but it can be minimised or confined to certain parts of the plant, and special provisions can be made for the removal of the coke without long periodical interruption of the operations.

In conjunction with Drs. Lomax and Thole, Dr. Dunstan surveyed the cracking problems eight years ago in the same place. In dealing now with the progress made in the last decade he could only refer to American practice, apart from his own experiments and the remarkable researches of Bergius. The only vapour-phase, atmospheric-pressure process which Dr. Dunstan mentioned, was that of Ramage, which is worked at Detroit and, industrially, at Tulsa. The oil (gas oil from crudes was first used) is boiled in a still at a pressure of about 5 lb. per square inch, and the vapours, mixed with steam, are led into cracking tubes packed with hematite, which

seems to last a year and more, if an air is blown through for a few minutes, once every 24 hours, to remove the sulphur adsorbed. The cracking tubes at Detroit were heated electrically in sections of 10 ft.; at Tulsa 63 tubes, 20 ft. by 6 in., are arranged in rows of seven. In the first half of the tube the temperature rises to 480 deg. C. and in the second to 650 deg. C. The spirit produced resembles other cracked spirits, the loss of gas and oil amounting at Detroit to 22·6 per cent., and Ramage claims also to be able to convert higher aromatic hydrocarbons into benzene, which is certainly possible and has been done by F. Fischer, to whom Dr. Dunstan alluded.

Before proceeding to the liquid-phase processes, Dr. Dunstan referred to the intermediate type process of Fleming, who distils and cracks in upright stills, 30 ft. high and 10 ft. diameter, because the coke does not adhere much to vertical walls, the process occupying 60 hours to 80 hours. Of the liquid-phase—or rather two-phase—processes, he considered the Dubbs process, now adopted in 113 plant units actually in operation or under construction in North and South America, in the East, Borneo and Japan, as one of the most successful. He also gave particulars of the Roy Cross and the Carlton Ellis processes; the Burton process, which held the field when he reported eight years ago, was now being displaced by others. In the standard Dubbs unit, which Dr. Dunstan was able to explain by the aid of a large model, due to the Universal Oil Products Company, of Chicago, the oil was pumped at a uniform rate through a heating coil (in a furnace) and passed partly into a welded reaction chamber, 15 ft. high, 10 ft. diameter, and partly into the top of the dephlegmator, in which it was preheated by the condensing vapours. The heater coil consisted of fifty 4 in. tubes, 30 ft. long, connected in series by return bends; the furnace was side-fired and divided into a combustion chamber and a heating chamber, the cracking temperature being 450 deg. The reaction chamber was not heated but heavily lagged. The vapours passed into the dephlegmator chamber, the heavy portions returning to the heating coils. The coke capacity of the reaction chamber was 30 tons; to facilitate the removal of the coke, a steel chain was suspended in a helix on the inner wall and withdrawn at intervals. The temperature of the dephlegmator was 395 deg. C. at the bottom; the condensed heavy oils and the raw oil, preheated to about 300 deg. C., passed back to the cracking tubes. The light vapours rose to the top and were discharged into the condenser, the condensate and gas flowing into a receiver. Up to that point the entire system was under a pressure of 140 lb. per square inch. The Dubbs process was the only one which could successfully crack commercial fuel oil, or topped crude oil without pre-treatment. It yielded 42 per cent. of Navy gasoline and a good coke that could be briquetted without binder, and the process was safe and easily controlled.

The Cross process (originally a vapour-phase process) resembled the Dubbs in that the heating and reaction zones were separated and no heat applied to the reaction chamber. But this chamber was a horizontal steel drum, 40 ft. by 38 in., with walls 3 in. thick, and the working conditions differed. In the upper bank of the heating coils, which served as preheaters, the flow was downward while in the lower bank (the cracking tubes) the flow was upward. A pressure of 600 to 700 lb. per square inch was maintained on the whole system. Normally, about 1 per cent. of coke was produced. The Carlton Ellis process, one of the latest developments, taken up by the Standard Oil Company and the Invincible Oil Company, was practically a combination of a crude still and a cracking still and did not carry pressure right through the system; the process was distinguished by great flexibility as to raw materials. The oil passed, at 350 lb. per square inch, through the coils into the "soaking drums," which were upright cylinders; the gasoline produced could be treated as straight-run spirit without blending.

Dr. Dunstan further outlined his views on cracking as successfully applied in the Auld-Dunstan-Herring experimental plant and to a large variety of oils. He advocated a liquid (not dual) phase, three-stage process. In the first stage, the oil is carefully heated up to not more than 25 deg. above the optimum-decomposition temperature in the "thermolyser" pipe or pipe system; in the second stage the heating is quickly pushed 20 deg. higher in the "reactor," where carbon deposition will take place; the third stage comprises dephlegmation and condensation.

Dr. Dunstan also discussed the Bergius process,* on which Dr. Ormandy subsequently gave further information. Bergius originally studied the formation of coal and produced a kind of bituminous coal from cellulose (wood, &c.) in his autoclave for high temperatures and pressures. Afterwards he converted inferior coal into oil by sealing it up with water and hydrogen, and also obtained motor spirit by spraying heavy oil together with hydrogen into his autoclave, initially heated to 400 deg. C.; the reaction proceeds endothermically, and the pressure may rise to 300 atmospheres. Such reactions may take place even in nitrogen atmospheres, the breakdown of some of the hydrocarbons (or of the water) supplying the necessary hydrogen. Dr. Ormandy did not say anything on the oil hydrogenation, which is carried out in Rheinan on a fairly large scale; but he had seen quantities of 10 kg. of oil prepared by Bergius from coal.

The process is said to proceed without formation of coke. Dr. Thole remarked during the discussion that the coke in cracking processes was a secondary decomposition product of a certain viscous tarry matter. That is further to be investigated, and Dr. Dunstan and his collaborators are studying cracking in silica vessels. Another subject discussed was the examination of the cracked spirits. These differ from straight-run spirits, and the conventional, now standardised, gasoline tests are not directly applicable to cracked spirits, or their results are at any rate not directly comparable with ordinary gasoline tests.

NOTES.

Inquiry on French Naval Engineering.

The plugs of three boiler tubes in the French battleship Courbet gave way recently; three men were killed and ten were injured. A court of enquiry censured the captain and two engineer officers, but found also that the accident was due to "certain deep laid causes which went beyond personal responsibilities." A committee of enquiry was therefore appointed after the court had given judgment, to decide whether any personal responsibility existed (i) with regard to boilers constructed before 1922; and (ii) with regard to naval construction in general, "more particularly in respect to those sections of it which are concerned with testing and fitting." These very wide terms of reference imply that French naval construction in the past few years has caused uneasiness. In the meanwhile, the new minister of the marine, Monsieur Dumesnil, has set up a new permanent committee at the Rue Royale to "study the use of machinery and boilers in the new ships, and to decide all questions relative to the upkeep and management of such material." As it is hardly credible that no section of the French Admiralty has, hitherto had these very duties to perform, the new committee probably takes away some duties from an overworked department. The boilers of the Courbet were of the Niclausse type.

The British Industries Fair at Birmingham.

It has been decided to revert to February as the most convenient time for the Annual British Industries Fair, and the sixth of the series will be held next year from February 16 to February 27. The London section will be housed in the White City, and the Birmingham section in the permanent exhibition buildings at Castle Bromwich. It is the Birmingham Fair which is of the greater professional interest to our readers, as this is concerned more particularly with the engineering and metal trades, and in view of the efforts made by the Department of Overseas Trade and the Birmingham Chamber of Commerce to attract foreign buyers, it is especially desirable that manufacturers themselves should give the Fair greater support than has been the case hitherto. It is greatly to be deplored that some of the organised trade associations entirely ignore this form of national advertisement, and a foreign buyer might well have returned from previous Fairs with the conviction that there was no machine-tool industry at all in the country, and that such things as locomotives, steam engines, turbines, condensing plant, heavy-oil engines, &c., were not to be procured in England. The organisation of the Birmingham Fair is thoroughly efficient, being controlled by perhaps the most capable and active Chamber of Commerce in the country, and an increasing number of foreign buyers are attracted to it. If manufacturers feel that the expense of exhibiting heavy machinery precludes them showing it, they might well consider a display of photographs, and models attended by a competent representative. The number of enquiries which we ourselves receive as to the makers of certain articles and products shows that there is ample room or more activity on the part of the British manufacturer in giving publicity to his wares.

British Railway Employees.

A return recently prepared by the Statistical Department of the Ministry of Transport shows that the employees on British railways have increased by 18,795 during the past year, the aggregate number employed in March last being 700,573 of all grades. Of this total the London, Midland and Scottish Company employed 274,523, the London and North Eastern 207,528, the Great Western 117,113, and the Southern 70,484, the balance being made up by the London Underground and other systems. The engine-drivers and motormen last March numbered 38,062 and earned an average weekly wage of 106*s*. The goods and passenger guards numbered 24,807 and earned an average of 75*s*. 6*d*. per week. Signalmen, numbering 29,265, with nominal rates of pay varying from 48*s*. to 75*s*., according to district, earned 68*s*. 4*d*. on an average; goods porters earned 53*s*. 10*d*.; uniformed police constables 74*s*. 4*d*.; motor and steam lorry drivers 63*s*. 11*d*., and locomotive shed labourers 54*s*. 6*d*. The lowest average weekly earnings given for any class of men appear to be 50*s*. 9*d*. for grade 2 porters of the traffic department, but, of course, the gratuities of the public are not included in this figure. Crossing keepers, with no such adventitious source of revenue, earned an average of 51*s*. 7*d*., but their duties are not arduous. Signal-lamp men in the traffic department earned 51*s*. 10*d*. and engine cleaners 53*s*. 2*d*. A separate table dealing with "Mechanics and Artisans" shows that riveters earned an average of 85*s*. 4*d*. during the last week of March, moulders earned 84*s*., smiths 82*s*., bricklayers in the locomotive, carriage and wagon departments 80*s*., fitters, turners and erectors in the same departments 79*s*. 1*d*. and machinists 73*s*. The lowest earnings of unskilled labour amounted to 47*s*. 2*d*. per week, this being received by marine and dock labourers. Labourers in the locomotive, carriage and wagon departments earned on an average 56*s*. 7*d*. per week. The report gives, in the case of every class of railway employee, the standard rates of wages on July 1, 1923, and July 1, 1924, as well as the average weekly wage and the average weekly earnings for the last week in March of the two years. The earnings are usually substantially greater than the weekly wage, on account of overtime, &c. The report, which enables most useful comparisons to be made, can be obtained from H.M. Stationery Office, London, for the price of 2*s*. 6*d*. net.

LITERATURE.

Road Engineering. By E. L. Leeming, M.Sc. In the series of Glasgow Text Books. Edited by G. Moncur. London: Constable and Co. 1924. [Price 18*s*. net.]

The application of the internal combustion engine to the road vehicle has worked a revolution in the means of transport, and the consequences are as yet by no means fully developed. The King's highway, like canals, was falling into disuse, and the railway was regarded as the only possible means for the conveyance of heavy traffic with rapidity and certainty. Under the altered conditions, the

* Illustrated, with its conical steel joint, on page 262 of our issue of August 22, 1913.

public roads have now assumed a prominent place in the life, in the business relations and in the commercial activities of the nation. But to derive the full advantages enlarged traffic offers, the roads must be rendered more efficient and made to acquire a very different character from the water-bound MacAdam highways that were controlled by local authorities, exercising very limited powers within narrow boundaries. Much transformation and reconstruction is necessary to convert the roads that sufficed in the past into the efficient weight supporting, smooth surfaced, continuous highways now demanded.

It is to meet the urgency of the demand for improved communication, and to assist those who are remodelling our roads in the light of the new conditions, that Mr. Leeming has prepared this treatise. The subject bristles with difficulties, both technical and fiscal, but the author prudently leaves the latter on one side, remarking, however, that the principle is established that the traffic using the road should bear the cost. We may say, in passing, that we doubt if this principle is as fully admitted as the author would persuade himself, and we submit it would be more correct to say that the traffic is prepared to pay some of the cost. It has been urged, and perhaps proved, that the extra road expenditure necessitated by the increasing number and weight of motor vehicles should be estimated at not less than 25,000,000*l.* per annum. The proceeds from motor vehicle licences in 1923 amounted to about 13,000,000*l.* Consequently the road users seem to be heavily subsidised out of the national revenue, and this they are not likely to forego without a serious struggle.

Many excellent treatises have been published both in England and America dealing with road construction, in which every aspect of the subject has been adequately considered, but the author justifies the appearance of this work on the ground that it is desirable to discuss the problem of vehicle design and road construction as constituting one branch of engineering. The author dissents from the view, held apparently by many writers, that it should be the object of the road engineer to produce a road capable of supporting the present weight of traffic, with allowance for increase in the near future, and urges that the makers of vehicles should adopt types of construction calculated to do the least damage to existing roads. Undoubtedly, the author is right in his main contention that true economy demands that the two problems of form of vehicle and of road strengthening should proceed *pari passu*, and that a well-directed policy requires that the road authorities should not be asked to produce a road capable of resisting any weight or any type of vehicle that readily fulfils a particular purpose. The road and vehicle should be regarded as one unit, and the interests of the user, of the road constructor, and of the community at large, should receive equal attention.

Hence in the matter of road construction much attention is given to the effects of camber in influencing road wear and preservation, to curves and super elevation on curves and to the improvement of hill roads. Mr. Leeming thinks that more attention should be paid to mathematical deductions, and as an example we presume, he discusses at some length the appropriateness of the Bernouilli Lemniscate as a suitable curve for effecting the transition at bends, or for easing the junction of roads. We have not calculated the differences in length or position between that curve and the parabola, but from the diagrams these should be slight. The use of the lemniscate to overcome the inconvenience of abrupt curves on gradients certainly seems unnecessary for the construction of the recommended form of profile would call for more expert supervision in the course of construction, and the nicety of curve acquired by rigorous measurement would soon be lost from wear and uneven settlement. The insistance on extra width of roadway required at bends is very pertinent. We are quite sure that the drivers of lorries and trailers, and probably few drivers of cars, could give a correct diagram of the curve traced by the wheels in negotiating a bend or hairpin turn.

As touching design the author will have the support of all road surveyors in his plea for a wider use of pneumatic tyres. In the interests of road economy there is urgent need for further legislation to define the limits within which solid tyres may be used. It is intimated that with the view of reducing damage to roads the transport department is considering the propriety of imposing lower taxation on pneumatic tyred vehicles, but we know nothing of the character of the proposals. The remarks on cushion tyres and on the "springing" of vehicles are well considered and deserve attention; of more importance as suggesting a change in road locomotives is the problem of the four wheel drive, a scheme that introduces some obvious advantages over rear-wheel driving. The effort at the driving wheels is reduced and the whole mass is jointly pulled by the front, and pushed by the rear wheels. The ill-effect of the rear wheel striking an obstruction is diminished, and the friction and wear on the road surface are very much less, and this last cannot but be an advantage to both the road and the user, which should compensate for the inconvenience of the drive through the front axle to the steering wheels. It is said that the tendency to form corrugations and create waves on the road surface is practically eliminated in the four-wheel drive, but this problem of road corrugation, though very exhaustively treated by the author, can hardly be regarded as settled. The effect of all the variables does not yet seem to be thoroughly determined.

The book is very illuminating in all practical matters and is directed closely to those which are pressing at the time. To those who are compelled to face the problems of strengthening and renewing old and feebly constructed roads, little fitted to modern traffic, the work should prove very useful, for much valuable experience is here digested and made easily accessible.

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LYMPNE TRIALS OF TWO-SEATER LIGHT AEROPLANES.

The competitive trials for two-seater light aeroplanes, in connection with which the Air Ministry offered prizes totalling 3,000*l.*, were duly carried out at Lympne last week and were concluded on the 4th instant. As mentioned on page 232 *ante*, the object of the Air Ministry prizes was to encourage the production of a two-seater machine suitable for training purposes, particularly in connection with the flying clubs it is proposed to establish in various parts of the country. For this purpose, a good range of speed, combined with the ability to get off and to land in a comparatively restricted space, is required, and the above-mentioned sum, divided into a first prize of 2,000*l.* and a second prize of 1,000*l.*, was awarded to the entrants of the two machines giving the best performances in these respects. The first prize was secured by Messrs. William Beardmore and Co., Limited, Dalmuir, with a monoplane named "Wee Bee I," which is described below, while the second prize went to the Bristol Aeroplane Company, Limited, Filton House, Bristol, as a result of the performance of their machine named "Brownie," also a monoplane; both these machines were fitted with the Bristol "Cherub" engine. Several other bodies and individuals offered prizes in connection with the trials, the total sum provided in this way amounting to 900*l.*

Altogether 15 machines (7 monoplanes and 8 biplanes) arrived to take part in the trials, which were organised by the Royal Aero Club. Eliminating trials were first carried out to establish the conditions of the competition that each machine could be dismantled and folded, transported a distance of 25 yards, and placed in a shed 10 ft. wide. The machine had then to be taken out of the shed, and re-erected by two persons in not more than two hours. A further preliminary test to indicate that the machine could be flown satisfactorily by a pilot sitting in either of the two seats was also carried out. Eight of the machines, it is understood, failed to pass these eliminating trials, mainly on account of engine troubles, so that the actual trials were carried out with the remaining seven.

In the speed-range trials, on the results of which, in conjunction with getting-off and pulling-up tests, the main prizes were offered, the Beardmore machine attained a high-speed figure of 70·11 m.p.h. and a low-speed figure of 39·66 m.p.h., the corresponding figures for the Bristol machine being 65·19 m.p.h. and 38·73 m.p.h. The Bristol machine also secured an additional prize of 500*l.*, given by the Duke of Sutherland, for the machine having the best getting off and landing qualities, while a biplane fitted with an A.B.C. engine and entered by the Hawker Engineering Company, Limited, Kingston-on-Thames, secured the second prize in these particular tests. A reliability prize, offered by the Society of Motor Manufacturers and Traders and the British Cycle and Motor-Cycle Manufacturers' and Traders' Union for the greatest number of circuits flown throughout the week, was awarded for a biplane entered by the Cranwell Light Aeroplane Club, this machine having covered a distance of 762½ miles in a total flying time of 17 hr. 53 min. 18 sec. The first and second prizes for a 100-mile handicap race were won, respectively, by an Avro "Avis" biplane and a biplane, named "Wood Pigeon," entered by the Westland Aircraft Works, Yeovil. Another Bristol "Brownie" monoplane, fitted with metal wings, was third in this race.

In view of the excellent performance of the Beardmore "Wee Bee I" monoplane, some particulars of the design and construction of this machine should be of interest. Its appearance is shown by the photograph reproduced in Fig. 1 on the next page, and the clean aerodynamic design, which must have contributed materially towards the results achieved, will at once be apparent from this illustration. It will be noticed that the only external bracing employed is in the form of a pair of raking struts on each side of the machine connecting the wing spars with the bottom longerons of the fuselage. The general arrangement of the machine is illustrated in the front elevation, plan, and longitudinal section reproduced in Figs. 2, 3 and 4, respectively, and as the main dimensions are indicated on these illustrations it is unnecessary to repeat them here. Some particulars of the allocation of the weights, however, may be of interest. The total weight of the machine, including a passenger and pilot having a combined weight of 340 lb., is 837 lb., the other principal items included in the latter being 200 lb. for the wings and struts, 120 lb. for the engine and propeller, and 65 lb. for the fuselage. The weight of the undercarriage is 25 lb., and that of the tail unit 20 lb., the remainder being accounted for by the controls and instruments which weigh 20 lb., petrol and oil 35 lb., and tanks and connections 12 lb. As the wing area amounts to 187 sq. ft., the wing loading, for the total weight above mentioned, works out at 4·47 lb. per square foot, and as the maximum horse-power of the engine is 32·6 when running at 3,200 r.p.m., the power loading is 25·67 lb. per horse-power.

As already stated, the machine is fitted with a Bristol "Cherub" engine which has a cylinder capacity of 1,096 cubic centimetres and thus just comes within the maximum capacity of 1,100 cub. centimetres allowed by the conditions of the trials. The engine, which has already passed the Air Ministry type tests, has two air-cooled, horizontally-opposed cylinders with a bore of 85 mm. and a piston stroke of 96·5 mm. The cylinder heads are of aluminium alloy and are allowed to project through the cowling to facilitate cooling, as shown in Fig. 1. The engine, which is directly coupled to a propeller 4 ft. 6 in. in diameter and contains no gearing, weighs 81 lb. alone and the petrol consumption is given as 0·625 pint per horse-power hour. With this consumption, the machine can fly from 40 to 70 miles per gallon. The engine is mounted on an upper support of pyramid form constructed of Duralumin plate and on lower supports, also of Duralumin, but having steel diagonal tubes connected with the bulkhead corners. By simply removing four nuts, in addition, of course, to the petrol and oil connections, &c., the whole power unit can be removed from the machine for overhauling or replacement. A plain gravity feed to the zenith carburettor, which is located below the crankcase, is provided, petrol being supplied from a tank mounted in the centre section of the wings between the spars; the tank is clearly indicated in Fig. 3.

The monoplane wing is constructed on two box spars having plywood webs with spruce flanges, the sides and flanges being decreased in section from the point of maximum bending moment towards the wing tip to correspond with the reduced shearing forces and bending moments. The wing is pin jointed to the fuselage and braced by pairs of struts as previously mentioned; one strut of each pair is adjustable. The ribs are of spruce with plywood webs and are of the Warren-truss type, as shown in Fig. 4. Plywood 1 mm. in thickness is fitted over the whole of the leading edge, and this plywood is continued back just beyond the rear spar on the top and bottom surfaces of the wing in order to resist the bending due to the drag forces; no other drag bracing is employed. The ailerons, shown in Fig. 3, are of high aspect ratio, and they are operated from bell-crank levers by short push and pull rods in place of the more usual flexible cords and pulleys. The area of the ailerons is 21·5 sq. ft.

The fuselage, illustrated in Fig. 4, is constructed on six spruce longerons with bulkheads of spruce and three-ply wood, the whole being covered with birch plywood $\frac{1}{16}$-in. in thickness. Great strength, particularly in torsion, is claimed for this form of construction. Of the two cockpits, one is located just forward of the front main spar and the other immediately behind the rear spar. Their arrangement is shown in Figs. 3 and 4, and from the former it will be seen that a clear view forward on either side of the machine is secured for the front pilot by curving the deck fairing inwards. This feature is also noticeable in Fig. 1, from which it will be seen that the concave curvature of the deck fairing is continued along the whole length of the fuselage. Access to the front cockpit is arranged for by hinging a part of the leading edge of the wing, and, in the case of the rear cockpit, an opening, covered by a celluloid window in flight is provided in the trailing edge. Dual controls are fitted so that the machine can be flown from either cockpit. The undercarriage consists of a single bent tube passing through the fuselage and anchored by suitable fittings on the sides. The axle is of chrome-nickel steel designed so as to give sufficient flexibility for the absorption of the landing shocks and supported in fittings on trunnions which allow the necessary movement.

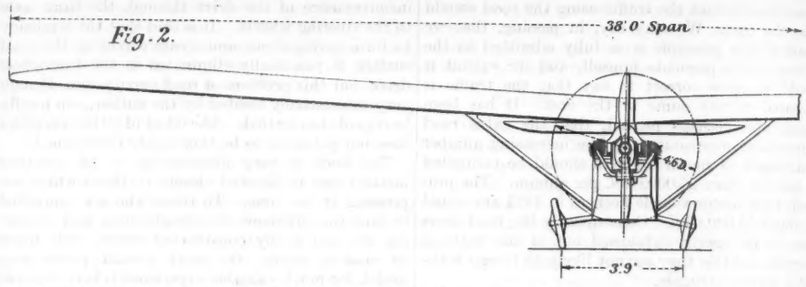
The whole tail unit is designed so that it is easily detachable. The fixed tail plane, which is 6·5 sq. ft. in area, is supported by a single cantilever spar, and is constructed in one piece with the rear portion of the fin, which is fitted with dowel pegs for locating it in the front portion; the total fin area provided is 4·3 sq. ft., while the rudder area is 7 sq. ft. The elevator, which is operated by a push and pull rod similarly to the ailerons, has an area of 13·5 sq. ft. Its design includes one feature which should be mentioned, viz., that the elevator is hinged to the fixed tail plane along its upper edge and provided with a Duralumin flap which covers the opening on the lower surface so that no gap is left.

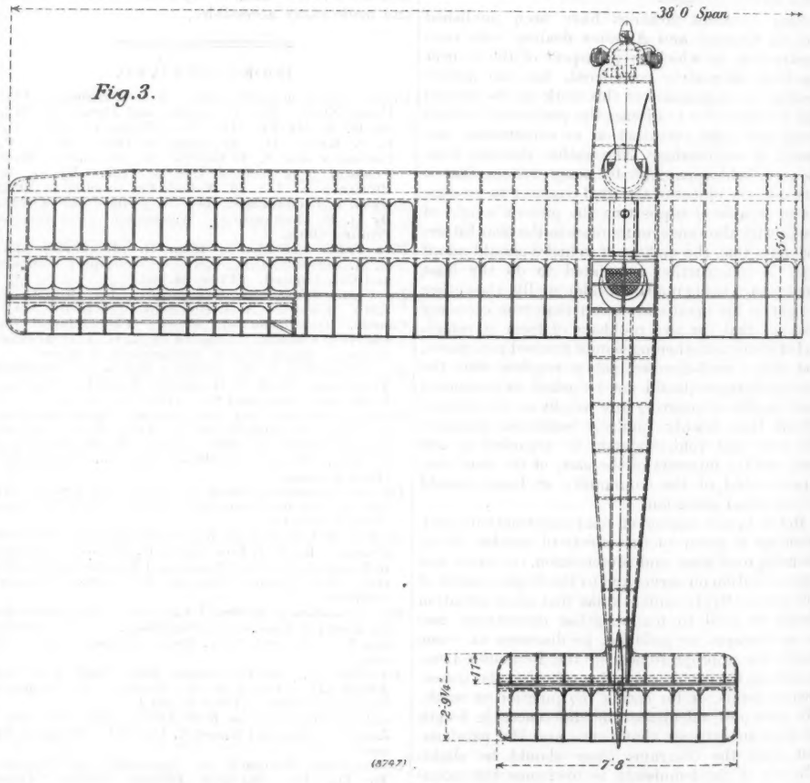
The whole design of the machine with respect to loading and factors of safety has been carried out in accordance with the Air Ministry requirements for a general-class certificate of airworthiness. It is perhaps hardly necessary to mention that very good performances were put up by several other machines which took part in the trials, the general results obtained serving to show that British manufacturers are quite capable of maintaining the lead with this class of aircraft that they obtained with the somewhat lighter machines taking part in last year's trials. Finally, we think the Air Ministry is to be congratulated on its policy in encouraging the development of these light machines, as also are the officials of the Royal Aero Club for their work in connection with the organisation of the trials.

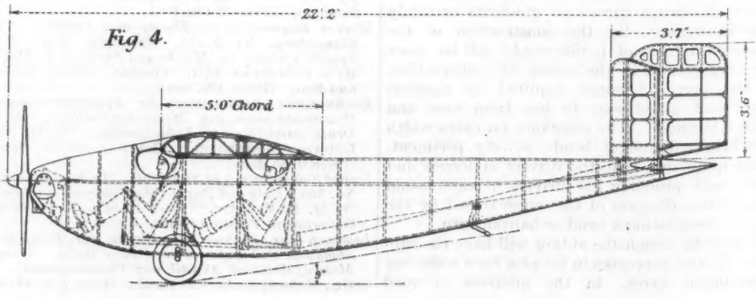
THE "WEE BEE I" TWO-SEATER LIGHT AEROPLANE.

MESSRS. WILLIAM BEARDMORE AND CO., LIMITED, DALMUIR.

Fig. 1.







LABOUR NOTES.

On the facts disclosed by Sir Robert Hadfield and others, an industrial truce of some kind or other is clearly necessary. How to bring one about is, however, a baffling problem whose complexities increase the closer one studies it. It is suggested, for instance, by Mr. Barnes, that a grand conference of representative employers and trade unionists should make an effort to find a satisfactory formula. That pre-supposes, however, (1) that all employers are organised in their respective industries and (2) that a trade union body exists which can effectively negotiate on such a subject, whereas, in fact, there are many unassociated or un-federated employers and the General Council of the Trade Union Congress cannot act on any subject without express authority—in other words, cannot bind its affiliated unions. The way to achievement of the desired object nevertheless lies through such a congress as is proposed. The executive authority of the Confederation of Employers' Organisations ought to be able to get together a comprehensive representation of employers for a discussion of the question, and the General Council of the Trade Union Congress could ask a special congress to give it power to explore the possibilities of agreement. If a formula were the result of a meeting between the parties—something like, say, the engineering provisions for avoiding disputes or the proposed conciliation scheme for the Tramways industry or the railway agreement—the affiliated employers' associations on the one hand and the affiliated unions on the other, could be balloted on it.

The objection may be urged that it would not be possible to apply one agreement to all industries. The Provisions for Avoiding Disputes are, however, easily adaptable to the case of any industry, and round them each trade and its unions could build whatever working conditions suited them. The procedure which has been indicated would necessarily take time, but only in some such way can the problem, in our opinion, be solved. The parties directly concerned must mutually agree to end the present deplorable state of affairs, and the greater the freedom of their deliberations is from the interference of outsiders—even well-meaning outsiders—the more lasting will their agreement be. Under such an arrangement as has been outlined there would be no stoppage of work until every possibility of adjustment had been examined locally and centrally. The rank and file of labour affect, on occasion, to distrust all conciliation machinery and to rely on their ability to enforce their demands on employers. The history of the Amalgamated Society of Engineers from 1897 till the formation of the Amalgamated Engineering Union proves conclusively, however, that there is no foundation for their fears. Under the organisation's agreements—all of which included provisions for avoiding disputes—with the Engineering Employers' Federation its funds and membership steadily grew, wages appreciably increased and working conditions were improved.

On October 7 the Umpire under the Unemployment Insurance Acts heard an appeal by the Unemployment Insurance authorities on the question of unemployment pay for 1,700 Kent miners who are idle in consequence of a dispute with the coalowners over the National Wages Agreement. The coalowners' case was that they were willing to pay under the National Agreement, but could not keep the collieries going if the base rates remained as at present. On behalf of the men, it was stated that the base rates could be altered by agreement on three months' notice being given. The notice was not given, the full wages were not paid, and the men went on strike. The Umpire decided in favour of the men's claim.

The engineering industry's provisions for avoiding disputes are less involved than some machinery devised with the same object, and on that account recommend themselves to the consideration of those who desire more or less prolonged industrial peace. When a difference arises and the workers and their representative on the spot fail to agree with the employers' representative, the point is automatically transferred to the consideration of a local conference which must meet within a given time. If there is still failure to agree, the matter then goes on the agenda for the next monthly central conference at York. If there is failure to agree there, the provisions are exhausted, and the parties are free to take whatever course they choose.

The procedure proposed for the tramways industry is much more elaborate. Agreements are to be national, and all applications from either side for revision of wages or conditions are to be submitted to the Joint Council. If agreement on any question is not reached by the Council in two hours' discussion, the claim is automatically remitted to a standing Wages Committee, consisting of the chairman of the National Council and 10 members—five chosen by the employers' side and five by the workers' side. This committee is to report to the Council within 28 days. If the Council, with the report before it, fails to reach agreement within 14 days, the claim becomes the subject of consideration by a tribunal composed of 10 members of the Council, of which five are chosen by each side, four co-opted members, each side nominating two, and a chairman appointed by the Council. Each member is required to vote, and the chairman has only one vote. With 15 members all required to vote there must, obviously, be a decision. It will be interesting to observe how this plan works out in the case of the difference which is now under discussion.

According to the "Labour Press Service" some considerable time will elapse before a critical stage is reached in the negotiations between the railwaymen's unions and the railway companies on the new national programme drawn up by the N.U.R. The Railway Managers will be asked to fix a date for a meeting with the Negotiating Committee of the N.U.R. to consider the programme. If this meeting fails to reach an agreed settlement the programme will then go through the conciliation machinery set up by the Railway Act. Thus, the next step will be the consideration of proposals by the Central Wages Board on which both parties have equal voting power. These proceedings are private, and the chief value of this step is that both sides can state their position frankly. If the results are inconclusive, the programme will then come before the National Wages Board, which will have Sir William Mackenzie as chairman.

There are, it seems, nine points in all in the National Minority Movement's Metal Workers' programme, They are :—

(1) An increase in wages of 20*s.* per week on all existing rates to all grades, with an ultimate demand for 4*l.* per week minimum wage.

(2) The establishment of a 44-hour working week and the abolition of overtime.

(3) The establishment of Factory committees representing all grades of workers in the factory or workshop.

(4) The rebuilding of unions. The revival of spirit and interest amongst the present members, and a campaign for bringing into the unions those at present outside. Every metal-worker a trade unionist.

(5) The complete organising of all women in the metal trades into the unions.

(6) Control by the unions of all youths and apprentices.

(7) The collaboration of all unions in the engineering, shipbuilding, and iron and steel trades for united demands to the employers and for united industrial action.

(8) Amalgamation of all unions in the industry into one union for national workers.

(9) Affiliation of all unions in the industry to the International Metal Workers' Secretariat, and full support to the request of the Russian Metal Workers' Union for admittance into this International.

One of the points is, it will be observed, "control by the unions of all youths and apprentices." According to *The Worker's Weekly*, the official organ of the Communist Party of Great Britain, the Young Communist League, "enthused by the success of its mining campaign, is now making a determined effort to . . rally the young workers round the following concrete demands :—

"(1) An increase of 10*s.* per week on all existing rates of wages paid to young workers.
"(2) A six-hour day ; no overtime.
"(3) No piecework.
"(4) All work to have training value.
"(5) Right to strike with adult workers."

Many of the items in the foregoing programmes are, on their face, economically impracticable. It has, however, to be remembered that in putting them forward the Red International of Labour Unions and the Young Communist Party are less anxious to bring about improvement in the state of the workers than they are to capture Trade Unionism and, through its organisation, destroy industry as it is at present organised. Most of the "demands" are far ahead of orthodox Trade Unionism's authorised programmes and concession of them would mean the scrapping of numerous agreements. If trade unionists were wise they would lose no time in disciplining these headstrong gentlemen, for the logical conclusion of successful propaganda along these lines is impoverished organisations powerless to do anything at all for their members.

Recently, the Belfast shipbuilding and ship-repairing employers offered to increase the wages of the members of the Amalgamated Engineering Union in their employment by 2*s.* per week, thus putting the engineering trades on the same footing as the shipyard trades so far as recent advances were concerned. The offer has now been formally accepted by a majority in a ballot vote.

The Worker, the official organ of the British Bureau of the Red International of Labour Unions, gives an interesting account of a recent examination of the registers of Moscow Labour Exchange. The results of the investigation were, it says, convincing proof of the urgent necessity of reforming both the system of relieving the unemployed and the registration of the unemployed by the Labour Exchange. The examination, which affected 107,688 unemployed, was carried out by visiting the unemployed and having talks with them and with representatives of the managements of the houses in which they lived, as well as by investigating the actual conditions under which they lived. As a result of these and other inquiries 42,117 of the unemployed, or 39·2 per cent., were dropped from the lists. Most of the excluded lived in the neighbourhood of the largest Moscow market—Sukharevka—where about 75 per cent. of the alleged unemployed were struck off the lists. In the centre of the city 50 per cent. were dropped, while in the outskirts, populated chiefly by workers, only 20 per cent. were excluded. The examination showed that many of those registered had already found employment, while others had left Moscow.

A number of characteristic cases of pseudo-unemployment were, it is added, discovered. Among the unemployed, some were found to own automobiles. In some of the apartments occupied by "unemployed" the investigators were not admitted for fear that they might be unclean and smudge their furniture. The unemployed lists contained names of ex-police officers and former owners of the biggest factories. There were among them also former dukes and officers of the court. All these unemployed were, "of course," immediately dropped from the lists, and many of the unemployed who had not previously been receiving the unemployment grant were placed on them.

A report published by the All-Russian Central Council of Trade Unions states that in the year 1922 the income of the "Central" was 5,678 milliards of Soviet roubles, 331 milliards being contributions from the affiliated unions and 5,027 milliards derived from State funds (5·8 per cent. against 88·5 per cent.). In the year 1923 the total income was 1,997,246 gold roubles, the contributions from affiliated unions being 132,804, and the moneys received from State funds 1,816,115 gold roubles (6·6 per cent. against 90 per cent.). In the first quarter of 1924 the Central Council had an income of 867,458 gold roubles, the trade unions contributing 61,968 and the State 796,044 gold roubles (7·1 per cent. against 91·8 per cent.).

The Ministry of Labour states that the number of unemployed persons on the registers of Employment Exchanges in Great Britain on September 29, 1924, was 1,198,800—903,700 men, 37,700 boys, 223,900 women and 33,500 girls. The total is 18,510 more than that for September 22, 1924, but 86,823 less than that for December 31, 1923. The number registered on September 22, 1924, was 16,250 greater than that for September 15.

The miners' agent in the Forest of Dean is reported to have informed a mass meeting of the men on October 7 that the largest collieries in the West Dean area had conceded the full terms of the National Wage Agreement and given an undertaking to disburse all back pay by October 24. Discussions have been begun, it was stated, with the Waterloo and Princess Royal Collieries.

The Industrial Court has issued its award in the wages reference submitted by the Joint Trade Union Movement and the London County Council. Of the war bonus of 26*s.* 6*s.* per week originally enjoyed by the men, 16*s.* 6*d.* was taken off when wages in the engineering trade were reduced in 1922. Eleven shillings of that was subsequently restored in two instalments, each of 5*s.* 6*d.* and the restoration of the third instalment of 5*s.* 6*d.* was now claimed on the ground that the rates paid by the Council compared unfavourably with those paid by the L.G.O.C., the companies operating tramways in the metropolitan area and the London Borough Councils. The decision of the Court was that the claim had not been established.

Society of Chemical Industry.—The programme for the session 1924–25 of the Chemical Engineering Group of the Society of Chemical Industry has now been arranged, and the first meeting will be held on October 23 at 5 p.m. in the Kelvin Room of the Engineers' Club, 39, Coventry-street, London, W.1, when papers dealing with crystallisation will be read by Professor T. V. Barker and Mr. Hugh Griffiths. Information regarding succeeding meetings may be had from the Secretary of the Society, Mr. H. Talbot, at Abbey House, Victoria-street, Westminster, London, S.W.1.

THE COLLIERY AT THE BRITISH EMPIRE EXHIBITION.

(*Concluded from page* 413.)

The plant above ground comprises a complete workshop equipped with a smith's hearth and a pneumatic 5-cwt. power hammer, constructed by Messrs. Alldays and Onions, Limited, of Birmingham. The machine tools supplied by Messrs. T. W. Ward, Limited, include a planing machine 6 ft. by 2 ft. 6 in. by 2 ft. 3 in.; sliding, surfacing and screw-cutting gap-bed lathes 9 in. centre by 12 ft. bed and 13 in. centre by 20 ft. bed; a radial drill with 4-ft. arm; a shaping machine with automatic feeds to the slide and vertical head; pipe-screwing machines to take from ⅛ in. up to 6 in.; parallel vices and small tools.

The motor ambulance garage contains a motor ambulance, the body of which is fitted on a Daimler chassis. Rescue apparatus of two varieties, constructed respectively by Messrs. Siebe, Gorman and Co., Limited, and the Mining Engineering Company, Limited, is arranged on the walls.

A shaker conveyor with compressed air drive, constructed by the Mining Appliances Company, Limited, of Sheffield, is shown near the creepers for elevating the tubs. The hammer drill, shown by the Climax Rock Drill and Engineering Works, Limited, of Carn Brea, Cornwall, is intended for drilling coal and the lighter stone for blasting. This drill is shown in detail in Figs. 160 and 161, and in a general view, Fig. 162, above. It is of light weight, 25 lb., and fast rotation, working with either solid or hollow twisted auger steel, and capable of drilling holes up to 8 ft. deep either horizontally or vertically in coal or stone. It is fitted with a blow-out valve A, Fig. 160, under the control of the operator, for enabling an extra blast of live air to be sent down the drill when required. The ratchet ring B is fitted with lugs, which lock into grooves in the handle forging, and prevent it from rotating. The tool holder C is usually made to take drill shanks ⅞ in. square by 3½ in. long. The details shown are: D, drill extractor; E, valve seating packing; F, valve; G, valve cage; and H, the valve seating.

The valve gear is of the tubular type, to give a large number of blows per minute with fast rotation.

The Climax percussion coal cutter is shown in section and detail in Figs. 163 and 164, and in general view and at work in Figs. 165 and 166, opposite. This machine resembles the reciprocating rock drill, but delivers a blow of a different character. The stroke is considerably longer and the weight less than for a drill of the same size; the piston rod J in this case terminates in a taper instead of forming a large chuck. The cradle K, which is fitted with a feed screw handle L at the end is capable of being rotated by hand round the axis of a worm wheel by means of the worm handle shown in Fig. 165. A rotation sleeve clamped round the column carries the cone seating on which the machine is mounted, and also the worm. The column is fitted with a jack screw operated by ratchet gear, shown in Figs. 165 and 166, for tightening it in place. The worm wheel is itself clamped and keyed to the column; the mounting shown in the illustrations is intended for undercutting or horizontal work only, a different fitting being used for shearing or vertical work. The internal construction resembles that of the hammer drill, the details shown in Figs. 163 and 164 being: M, ratchet ring; N, clamp ring bolt; O, air nipple and dust cap; and P, the bent coupling piece and coupling nut.

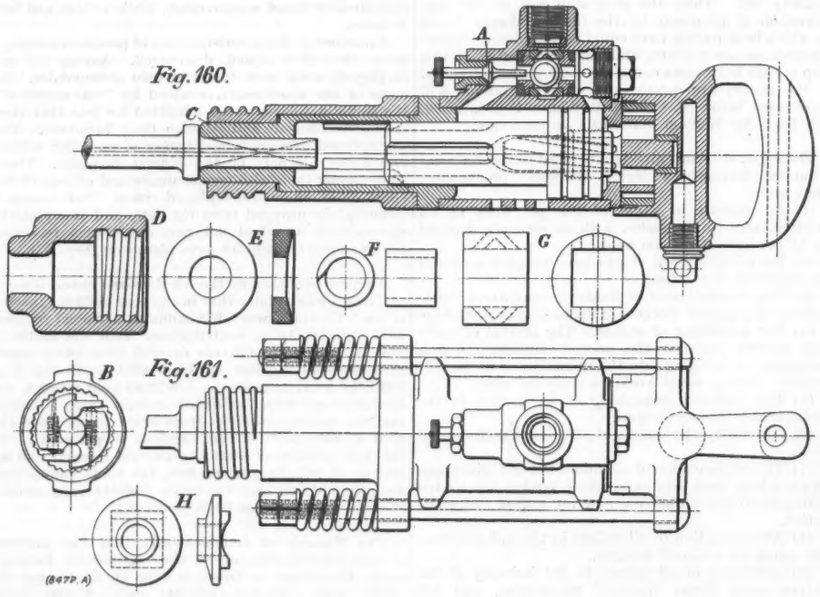


Fig. 160.

Fig. 161.

Figs. 160 to 162. Rock Drill; The Climax Rock Drill and Engineering Works, Limited.

The cylinder I is machined from a steel casting with V-slides on either side to fit the corresponding slides in the cradle. The valve chest Q is made from a steel stamping, and the valve R is machined from rolled steel bar, both being case-hardened and ground to size. The valve-box and bushings are so designed that the parts are all truly co-axial. The piston is turned from a nickel steel forging, and fitted at the junk end with a rifle nut to suit the fluted rifle bar, Fig. 163. The cradle K is a steel casting machined to suit the slides on the cylinder. The chuck is bored taper at the one end to fit the piston and at the other end to suit the extension steels which are usually supplied in 20 in., 40 in., 60 in. or 80 in. lengths, and are machined at the ends to suit the chuck and the five-prong picks used for cutting. The picks are generally 3¼ in. diameter, machined from solid carbon-steel stampings.

A complete range of pneumatic tools is exhibited in the Palace of Engineering by Messrs. Holman Bros., Limited, of Camborne; among these are a pneumatic pick weighing 16 lb., hammer drills of light weight (25 lb.) for coal and soft to medium rock, and heavy sinker drills weighing 115 lb. for boring holes up to 4 in. and even 6 in. diameter. These hammer drills are made of either the one or two-handed varieties, and either with or without a cradle and feed screw. This firm also specialises in machines for gripping and swaging drills and sharpening "X" bits.

Hand-boring machines, manufactured by Messrs. Matthias Spencer and Sons, of Sheffield, are shown in the mine, examples of this type being the Paragon and the Agrippa hand boring machines with pivoted supporting blocks, adjustable in a twin pillar, and ratchet levers both for drilling and for feeding. The Borok is a smaller hand drill fed from a barrel and designed by the same makers for use in very thin seams.

The removal of props from the worked-out portions of the mine was formerly, when effected by means of the hammer, attended with considerable danger, because the miner had to occupy the position in which he was most exposed to falls of roof. A range of appliances has been evolved for this work, among them being the "Sylvester," one of which is shown alongside a Diamond jigging conveyor, Fig. 110, Plate XXII, of our issue of August 15. Another is the "Sylat" prop withdrawer, made by Messrs. Hadfields, Limited, of Sheffield; with this appliance the leverage is 30 to 1, as against 7 to 1 in the chain and ringer withdrawer that first superseded the use of the hammer. The design in this case has been improved so as to permit the operator to stand close to the anchor prop at the maximum distance from the prop that is being pulled.

Fig. 162.

Several types of prop-puller manufactured by Messrs. Matthias Spencer and Sons are exhibited in the mine; of these the "Agrippa," an appliance of the rack-and-chain type, has a cranked end which keeps the rack parallel with the chain and facilitates the sliding of the chain-box, Fig. 167, page 530.

A further accessory is the "Klippa" chain-retaining box, Fig. 168, which enables the length of chain pulled in to be secured to the rack, and a fresh pull obtained whilst the slide-box is readjusted. With this appliance the length of pull is not limited to the length of the rack, and it is not necessary to release the tension before taking a fresh grip, the hold being taken automatically.

A third accessory is the "Rensha," Fig. 169, which utilises the pull to wrench the prop by twisting it from its position. With this appliance the hook end of the chain is arranged on the prop and secured in place by a spring connection. The free end of the chain is then passed through the wheel, the appliance arranged to straddle the chain on the prop, and the large hook placed in the slot at the back of the frame. The chain is then pulled

tightly through the frame and round the toothed pulley, thus fixing the "Rensha" at right angles to the prop. When fixed, the chain should be nearly tangential to the prop, and when the pull applied has brought the "Rensha" round till almost at right angles to the pulling position, the prop will usually be loosened enough to pull out direct.

The use of electricity for power distribution in mines has made it possible to improve the lighting—one of the worst features of underground working—and to enable the miner to see in the galleries and at the working faces. We have already seen that it is possible to make all the switchgear instruments and motors flameproof, and the same arrangements are made in the case of the lamps.

A very complete system of lighting devised by Messrs. W. Francis and Co., Limited, of Altrincham, has been installed in the colliery at Wembley. The fittings are of various types to suit central overhead positions for general lighting, inclined fittings for attachment to props or walls, and hand-lamps for use in driving headings. Care has been taken to conform with the Home Office requirements and the 1911 memoranda relating to the use of electricity in mines. A feature of the system is that three units are used, Fig. 170 and Fig. 171; a terminal box portion, a number of which may be fixed on a cable before it is erected; a combined switch and fuse portion which can be connected to the terminal box, thus forming a complete switch point; and a lantern portion which can be connected to any terminal box portion, thus forming a complete lighting point. The removal of switch or lantern portions by other than authorized persons can be prevented by the use of a special locking device in place of the ordinary wing nuts.

The terminal box is split in such manner that connection can be made without cutting the cable, which is bared in two places and attached to terminals, after which the box is assembled and compound filled. The lamp fitting is arranged to plug into the terminal box, the machined faces rendering the combination flameproof. This arrangement facilitates the removal of any defective lamp to the underground substation or other suitable place for repairs or fuse replacement. The interchangeability of the light fitting and switch in the terminal box has been considered specially with a view to the application of the system to collieries. The assembly of the components is shown in Fig. 170.

Any means that can tend to the diminution in the number of cases of miners nystagmus are, next to safety, of the greatest importance to the miner and to the colliery owner. Efforts are being made in Britain, and also in the French and Belgian mines, to reduce this evil, which is often supposed to be caused by the position which the miner is compelled to assume in the hand working of the seams, but is now very generally believed to be attributable to the scanty light afforded by the ordinary safety lamp, to the position it frequently occupies almost between the miner and his work, and to the colour of the light itself.

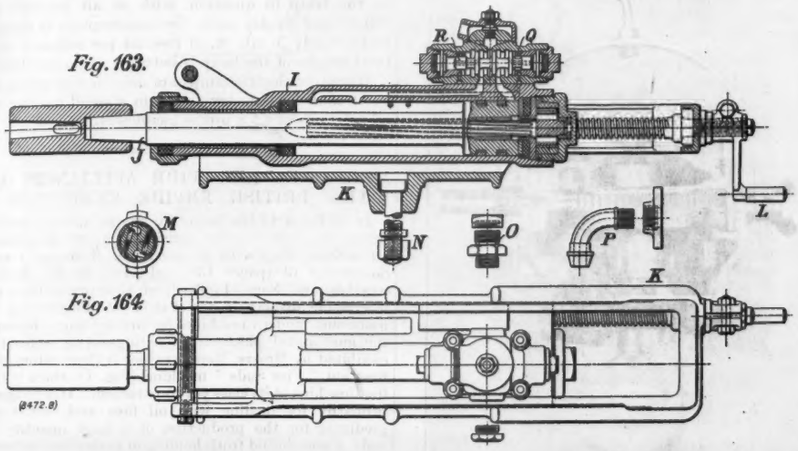


FIG. 166.

FIGS. 163 TO 166. PERCUSSION COAL CUTTER; THE CLIMAX ROCK DRILL AND ENGINEERING WORKS, LIMITED.

The miners' electric lamp of to-day, as manufactured by the Ceag Miners' Supply Company, Limited, of Barnsley, is the result of continuous improvements on their original pattern that won the first prize in the Home Office international competition of 1912. The production of a miners' lamp, which must be at the same time light, portable, and not liable to extinction when upset, alone took many years of study. The present Ceag lamps weigh 6½ lb. and contain a safety fuse, so arranged that in the event of the wall glass being broken the cell is automatically disconnected. The lamp is secured between two springs, which take up vertical and lateral shocks, and the lamp is switched on and off by rotating the top relatively to the bottom of the lamp. The accumulator is of the "jellac" type, using a semi-solid electrolyte which contains no free acid and is put into the cell in liquid form; it solidifies inside and thus renders the cell unspillable. The lamp is locked by a "magnetic" lock, which can only be unlocked by means of a powerful electromagnet, when a quarter-turn of the retaining ring releases all the parts of the lamp top. In order to obtain an absolutely dependable quality the lamp bulb itself is now manufactured by the Ceag Company.

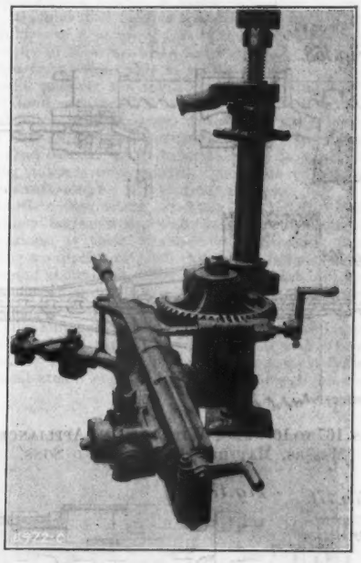
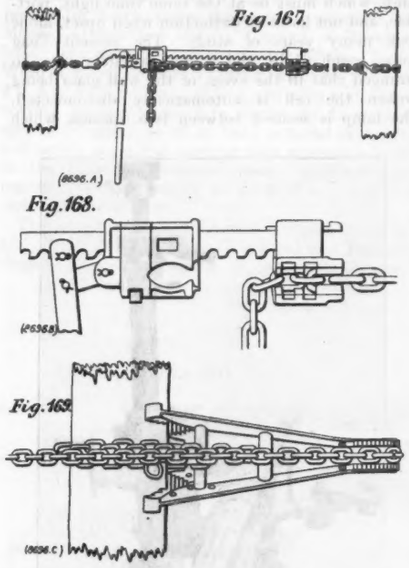


FIG. 165.

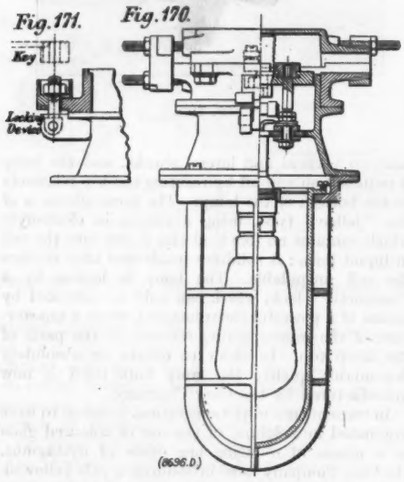
In consequence of the suggestion, believed to have originated in Belgium, of the use of coloured glass as a means of reducing one cause of nystagmus, the Ceag Company have introduced a pale yellowish green tinted well glass, giving a rather softer and more diffused light than the ordinary glass. Lamps of special pattern are made for officials, of the bull's eye, torch, signalling (red, green and white, by means of three stops) and "deputy" types. The latter combines the bull's eye and torch, either being switched on as desired by rotating the top of the lamp relatively to the bottom. All these special lamps are sealed with a lead rivet. Cap lamps connected by a short length of cable to the portable battery are also made. In order to improve the illumination of the work afforded by the ordinary lamp, a special pillarless lamp is made which is fitted with a reflector that gives, over an angle of 80 deg., increased illumination from the normal 1·4 candle power to a maximum of 2·4 candle power.

In a large mine it is not only necessary to have a system for exchanging lamps for the miners' checks, but also to provide charging stands, a generator and an instrument board for recharging the batteries. It is, moreover, essential that at regular intervals the lamps be taken to pieces, cleaned and kept in repair. For this purpose the magnetic unlocking device is used, containing a powerful electro-magnet, the pole-piece of which

can attract the hidden bolt in the lamp with sufficient power to overcome the locking spring and free the parts. Inspection is also necessary to ensure that the bulbs are replaced when necessary, and while the lamp is dismantled the well-glass should



Figs. 167 to 169. Prop-Withdrawing Appliances; Messrs. Matthias Spencer and Sons.



Figs. 170 and 171. Lamp and Fitting for Mine Lighting; Messrs. W. Francis and Co., Limited.

be cleaned by a rotating brush. Records are also kept of the life of the batteries and of the bulbs.

For mines provided with a compressed-air supply, but not having underground electric supply, a portable, turbine-driven self-contained generator and lamp, illustrated in Figs. 172 to 174, is made by the M.L. Magneto Syndicate, Limited, of Coventry. A short hollow shaft, running on ball bearings in the upper part of the lamp casing, carries on its upper part a ring of turbine blades built into a disc flywheel; to the lower part of this disc is attached a permanent magnet rotor, which revolves within a laminated stator carried in the lower part of the casing by a clamping ring. The magneto-generator is designed to supply alternating current at a practically constant voltage over a wide range of speed. The nozzle is mounted in a branch that projects tangentially from the casing and is fitted with a gauze air-filtering cap. The exhaust passes to the atmosphere through a port at the top of the casing, closed by a spring-loaded disc valve opening outwards. The glass cap covering the lamp bulb is continuously scavenged by air received from the lamp casing, and escaping through a hole in the recessed portion of the bottom wall. In order to ensure that the terminals may be dead if the protecting glass should be broken, a cut-out

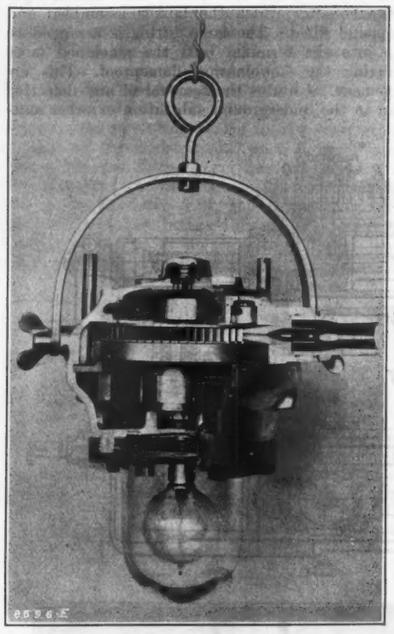
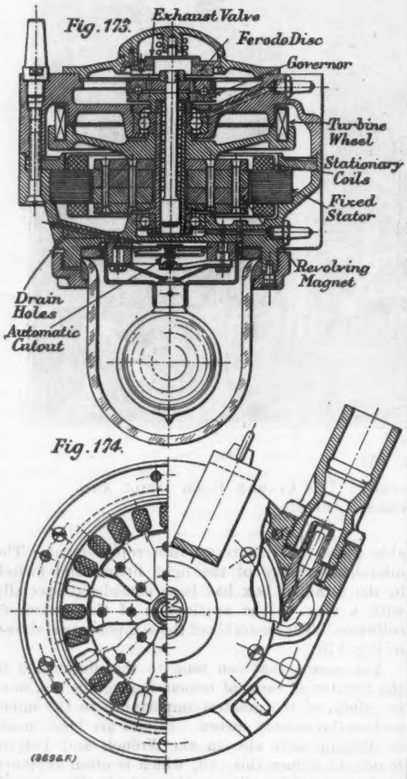


Fig. 172.



Figs. 172 to 174. Compressed-Air Turbine-Driven Electric Lamp; The M.L. Magneto Syndicate, Limited.

is provided, consisting of a flexible sided metallic chamber, similar to that of an aneroid barometer. The chamber is in connection with the atmosphere, but it is placed at the back of the lamp holder, where it is exposed to the exhaust pressure. The chamber carries a platinum contact, which engages with a fixed contact on the body of the lamp. If the pressures inside and outside the chamber are equal, the contacts are pressed together, short-circuiting the generator. Breakage of the glass or tampering with the points will therefore automatically make the lamp dead. An emergency governor is provided on the generator, and operates for an excess speed of 10 per cent. The lamp is of about 32 candle power (24 watts), and the ordinary 12-volt automobile lamp bulb can be used. In the lamp in question, with an air pressure of 100 lb. per square inch, the consumption is stated to be nearly 3 cub. ft. of free air per minute; the total weight of the lamp is between 14 lb. and 16 lb.

Wherever electric lamps are used in coal mines, it is, of course, necessary to retain a small number of oil safety lamps for use as gas detectors.

MERRYWEATHER FIRE APPLIANCES AT THE BRITISH EMPIRE EXHIBITION.

In addition to the large fire engine and the trailer pump on loan to the British Empire Exhibition authorities, dealt with in our issue, of August 1 and September 19 (pages 156 and 426), Messrs. Merryweather and Sons, Limited, of Greenwich, have an interesting display in the Palace of Engineering of numerous modern machines for fire fighting. Perhaps the most novel piece of fire-extinguishing apparatus exhibited by Messrs. Merryweather is their automobile first aid "Fire Suds" machine (Fig. 1) which is the first machine of its class yet constructed. It is designed primarily for dealing with oil fires and carries ingredients for the production of a large quantity of suds, a semi-liquid froth holding in suspension carbonic acid gas. It is now well established that a compound of this kind is the only really effective antidote for fires of burning oil, tar or substances having a lower specific gravity than water. The chassis upon which the fire-suds machine is constructed is of the same type as that of the fire ladder above referred to, but is fitted with a 50 b.h.p. motor. The superstructure is built up of mahogany with panel sides, the rear half being constructed to carry two galvanised steel tanks holding an alkaline solution forming the suds-producing material, and six separate lead-lined compartments carrying an acid solution. Each of the compartments has a separate valve-controlled outlet connecting with the suction pipe of a double chamber rotary pump, each chamber dealing with a separate solution. The pump is driven from an extension of the first motion shaft of the automobile gear box, and delivers the two liquid ingredients through separate parallel lines of hose wound on an hydraulic reel to a single delivery branch, where they mix and form the fire suds which is delivered under pressure on to the surface of burning oil; it quickly overspreads this, preventing the access of oxygen and most effectively extinguishing the flames. As soon as one of the compartments is exhausted, the others are brought into operation seriatim, in accordance with the size and nature of the fire to be extinguished. The solution carried makes a total quantity of 1,800 gallons of fire suds; this may be considered a sufficient supply for a fire of average dimensions, but it may be increased to any degree desired from a provision of dry ingredients carried on the machine.

In addition to the suds-producing apparatus, a tank of plain water of 40-gallon capacity is carried for first-aid use at an ordinary fire; the water is delivered by an entirely separate rotary pump, operated from the transmission gear, to an hydraulic reel carrying 180 ft. of rubber delivery hose, 1 in. in diameter. A compartment is also provided for carrying a supply of canvas delivery hose for use from street hydrants, and large boxes are fitted on each side of the chassis between the wheels for the storage of other necessary fire-fighting gear. Overhead is a light telescopic ladder.

From the above brief description it will be seen that a fire brigade equipped with such a machine is in a position to deal effectively with any description of outbreak to which it is called, other than such necessitating the use of powerful pumping apparatus, and Messrs. Merryweather are confident that owing to the constantly-increasing number of oil and petrol depots throughout the country a large demand exists for machines of this class.

Another interesting item of Messrs. Merryweathers' exhibit is their "Konus Kemik" portable fire-extinguisher, of which a large number are in commission throughout the Palace of Engineering for the fire protection of the stands. The "Konus Kemik" generates carbonic acid gas in an aqueous solution

under pressure by the mixture of sulphuric acid with a solution of bicarbonate of soda. The soda solution is contained in the "Kemik" itself, whilst the acid is carried in a hermetically-sealed glass tube which is fractured by the impact of a sliding lead weight. The apparatus acts solely by reversal. The discharge with the suds-producing compound being in the container itself. Upon reversal, the lead weight uncloses the orifice of the internal cylinder and the fire suds under pressure is produced. These types of apparatus have been most successful and make an extremely attractive display.

FIG. 1. FIRST AID SUDS MACHINE.

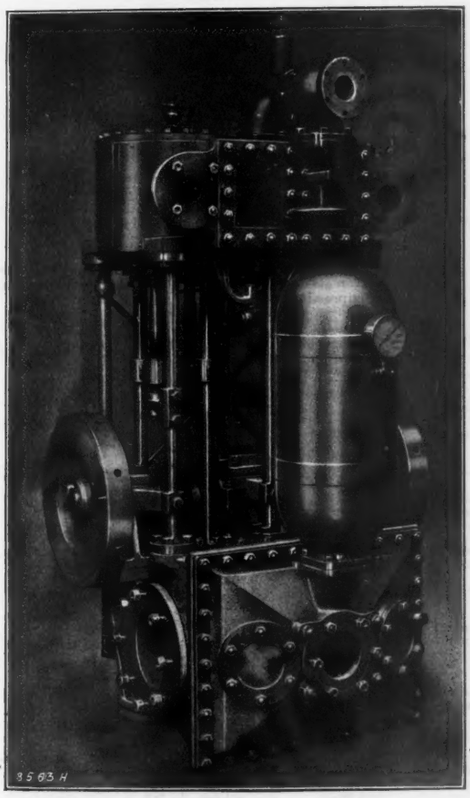


FIG. 2. 2,000-GALLON "GEM" FIRE AND SALVAGE PUMP.

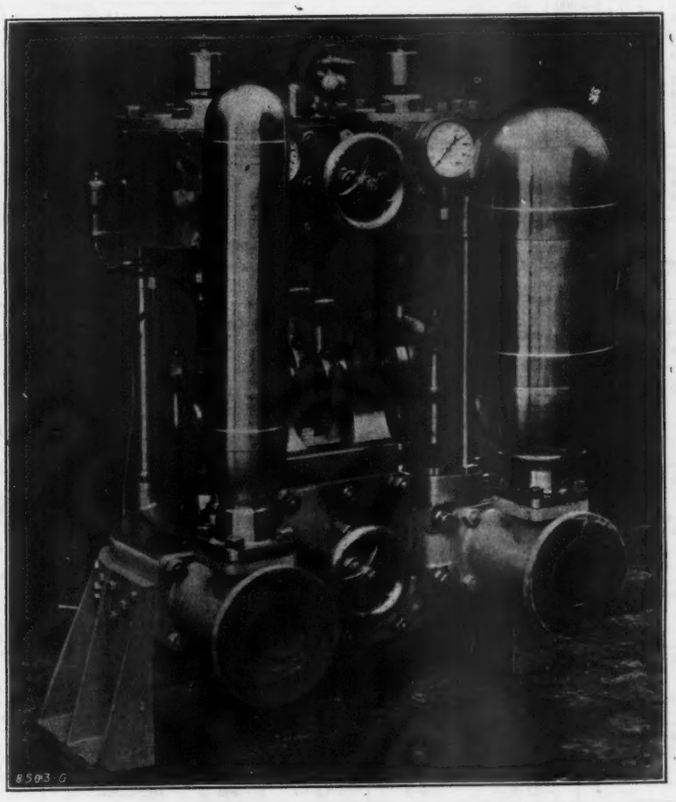


FIG. 3. 200-GALLON "GEM" FIRE AND SALVAGE PUMP.

outlet is in the gun-metal cover which closes the container, and being well above the level of the contents it is impossible for these to percolate by capillary attraction or by other cause, a defect common to many types having internal pipes. A "fire suds" apparatus is made of the same capacity and on the same lines as the "Konus Kemik," the only difference being in the method of carrying the ingredients. In the case of the fire suds apparatus, acid solution is in a removable copper cylinder, the orifice of which is closed by a lead ball, the alkaline solution

Messrs. Merryweather also show two examples of their double cylinder vertical "Greenwich Gem" steam pump, one of the largest and one of the smallest of their standard types of this class. The larger (Fig. 2) has a volumetric capacity of 2,000 gallons per minute, and is designed for a steam pressure at the stop valve of 180 lb. per sq. in.; the capacity of the smaller size is 200 gallons per minute (Fig. 3).

These pumps are most frequently in demand for ships, where pumps of large capacity are required for sea salvage and fire pumping duty, and where space is limited for their installation. Our illustrations of these pumps show the extremely compact nature of the design. The 2,000 gallon pump weighs only 54 cwt., the weight of the 200-gallon size is only 6 cwt.

These pumps are usually mounted below the water-line of a ship, and for fire-pumping duty take their supply from the ship's side through a sluice-valve and strainer box delivering into a deck discharge, fitted for the attachment of fire hose and usually carrying a double-swivelling monitor of sufficient size to take the whole of the output of the pump. The diameter of the monitor nozzle used under these circumstances is for the 2,000-gallon pump $2\frac{1}{2}$ in., and for the 200-gallon one $\frac{3}{4}$ in. For salvage-pumping duty a suction branch is taken to a deck fitting for the attachment of flexible suction pipe, and the great usefulness of a pump of this type for salvage work is specially in evidence when the water-line in a flooded compartment fluctuates to such a degree as to occasionally uncover the suction strainer. These pumps were used with marked success in the salving of the block-ships at Zeebrugge, where their high-pressure jets were of great advantage for clearing a passage in the sand bottom underneath the ships, through which lifting hawsers were passed. The same pumps were afterwards used for pumping-out purposes.

Another interesting example of Messrs. Merryweathers' machines, especially in relation to sea salvage operations, is their steam-driven centrifugal pump, having a capacity of 3,000 gallons per minute, against a head of about 40 ft. The pump has a cast-iron body, with suction and delivery branches 12 in. in diameter, the impeller chamber having flanged covers at the ends carrying long gun-metal sleeve bearings. The impeller is of the closed-vane type, of gun-metal with a bronze spindle. The pump is coupled direct to a single-cylinder vertical steam engine, running at a speed of about 700 revolutions per minute, which can be supplied in a range of sizes to suit the steam pressure available in the ship in which the pump is installed. The motion work runs in a totally enclosed crank-case, with forced lubrication to all working parts, and pump and engine are aligned on a cast-iron bedplate. This particular type of pump is made for fixing in a ship's engine-room, with the suction and delivery branches piped to deck. There is usually supplied with it a multiple deck suction fitting having four separate inlets each 6 in. in diameter for the attachment of flexible rubber suction piping.

THE EFFECT OF HIGH TEMPERATURE ON THE RANGE OF REPETITION STRESSES ON STEEL.*

By Professor F. C. Lea, D.Sc., M.Inst.C.E., M.I.Mech.E., and Mr. H. P. Budgen, M.Sc.

(*Concluded from page* 500.)

Description of the apparatus and method of experimenting.—Fig. 1 on page 533 shows the furnace in which tests were carried out at temperatures varying from 15 deg. C. to 800 deg. C. at 2,000 repetitions per minute.

The specimen at its upper end is screwed to the connector C, which is partially insulated from the upper part of the machine by the mica tube and mica washers shown in the figure. This arrangement was adopted to prevent, as far as possible, heat flowing upwards from the specimen. The lower end of the specimen is connected to C_1 which, in turn, is attached to the lower part of the machine. The electric furnace consists essentially of a steel tube along which are laid strips of uralite, and this is first wound round with nichrome wire connected to the terminals T and T$_1$. The inner tube is insulated with asbestos wool surrounded by a larger tube and the ends closed with thin plates. The temperature is measured by means of a thermo-couple touching the specimen as shown in the figure.

The specimen is fixed in the machine and the temperature raised gradually to the temperature of the test, the machine being adjusted carefully to allow for any expansion that may take place. When carrying out experiments at unequal ranges of stress, the specimen creeps quite perceptibly when the mean stress exceeds some specified amount. While the stresses are being applied, however, the machine can be adjusted to take up the elongations so as to preserve the air gaps at their original setting. The amount of the elongation can be estimated fairly approximately during the test by keeping a record of the numbers of turns of the adjusting wheel, or more accurately by recording the movement of the differential ammeter which is normally set at zero. This measures any permanent change of position of the oscillating armature between the opposing poles, due to an extension of the specimen. Tests showing the rate at which creep takes place have already been referred to in the introduction (see Fig. 5). When the tensile and compressive stress were at equal ranges, although the maximum stress exceeded the static creep stress, there was no perceptible creep of the specimen. The fracture was of the ordinary fatigue character.

* Paper read before the Engineering Section of the British Association at Toronto on August 11, 1924.

TABLE I.—0·14 *Carbon Steel.*

Showing the ranges of stress for various numbers of reversals at various temperatures for equal tensions and compressions.

Stress ± tons per sq. in.	No.	Reversals.	Temp. Deg. C.	Remarks.
16·41	1	7,196,000	15	B
19·19	2	611,000	,,	B
15·6	3	3,907,000	,,	B
15·29	4	21,063,000	,,	B
15·31	5	17,537,000	,,	B
16·3	1	891,000	202	B
15·78	2	1,402,000	216	B
15·37	3	5,231,000	198	B Stopped 10 min.
15·2	4	8,356,000	200	B ,,
15·34	5	9,425,000	203	B ,, 35 min.
17·8	1	2,351,000	290	B
17·92	2	4,906,000	310	B
17·75	3	9,878,000	308	B Stopped 3 hours.
19·52	1	332,000	398	B
18·94	2	2,816,000	402	B
18·4	3	4,772,000	409	B Stopped 2 min. four times
18·72	4	6,725,000	394	B ,, 5 hours.
18·56	5	9,431,000	399	B ,, 1 hour.
17·27	1	891,000	500	B
16·24	2	1,402,000	497	B
16·28	3	2,396,000	501	B
15·77	5	4,871,000	496	B Stopped 12 min.
15·6	4	8,892,000	506	B
15·2	1	340,000	603	B
14·29	2	2,732,000	600	B Stopped 10 min.
13·66	3	4,951,000	589	B ,, 3 min.
14·14	4	7,452,000	595	B

Results of Tests at various Temperatures on Three Steels for Equal Tensile and Compressive Stresses.

Compositions of the Steels.

	C. p.c.	Chr. p.c.	Ni. p.c.	Mn. p.c.	Si. p.c.	S. p.c.	P. p.c.
1. K4 steel ..	0·35	0·60	3½	..	..	..	..
2. 0·14 carbon steel	0·14	..	..	0·68	0·19	0·040	0·045
3. 82 steel ..	0·3	0·6	3·6	0·4	0·17	0·02	0·02

TABLE II.—0·14 Carbon Steel.

Showing the ranges of stress for various numbers of reversals at various temperatures for a mean stress of 10 tons per sq. in.

Mean Stress. Tons per square inch.	No.	Maximum Stress* Tension.	Minimum Stress.	Range of Stress.	Temp. ° C.	Reversals.	Remarks.
10	1	−19·47	−0·53	18·94	15	628,000	Broke.
	2	−19·38	+0·62	18·76	15	4,894,000	Stress increased.
	2	−20·05	+0·05	20·10	15	832,000	,,
	3	−19·22	−0·78	18·44	15	10,439,000	Broke.
	4	−19·41	−0·59	18·82	15	1,325,000	,,
	5	−17·425	−2·575	14·85	15	3,832,000	Stress increased.
	5	−21·32	+1·02	22·34	15	1,856,000	,,
	6	−19·41	−0·59	18·82	15	7,251,000	Broke.
10	1	−19·51	−0·49	19·02	153	225,000	Broke.
	2	−19·42	−0·56	18·86	148	351,000	,,
	3	−19·3	−0·7	18·6	147	2,392,000	,, St. 5 hrs.
	4	−19·11	−0·89	18·22	155	4,481,000	,,
	5	−19·18	−0·82	18·36	150	8,642,000	Not broke.
10	1	−19·78	−0·22	19·56	300	998,000	Broke. St. 10 hrs.
	2	−19·61	−0·39	19·22	315	989,000	,,
	3	−19·48	−0·52	18·96	302	2,196,000	,,
	4	−20·11	+0·11	20·22	298	3,461,000	,, St. 4 hrs.
	5	−19·4	−0·6	18·8	291	8,211,000 not broken	Stress raised several times.
10	1	−18·6	−1·4	17·2	431	1,251,000	Broke.
	2	−19·07	−0·93	18·14	440	5,409,000	,,
	3	−18·61	−1·39	17·22	437	7,721,000	,,
10	1	−18·58	−1·42	17·16	489	572,000	Broke.
	2	−19·05	−1·95	18·10	502	3,810,000	,, St. 4 hrs.
	3	−18·23	−1·77	16·46	499	7,419,000	,,
	4	−18·69	−1·31	17·28	505	8,951,000	Not broke.
10	1	−16·91	−3·09	13·82	655	310,000	Broke.
	2	−17·29	−2·71	14·58	660	1,821,000	,,
	3	−16·46	−3·54	12·92	661	5,352,000	,, St. 1 hr. 30 min.
	4	−16·89	−3·11	13·78	664	6,841,000	,,
10	1	−15·1	−4·9	10·2	700	582,000	Broke.
	2	−14·17	−5·83	8·34	715	2,361,000	,,
	3	−15·15	−4·85	10·30	692	6,723,000	,, St. 2 hrs.
	4	−14·68	−5·32	9·36	698	8,391,000	,, St. 5 hrs.

* Tensile stresses are indicated as −. Compressive stresses are indicated as +.

TABLE III.—0·14 Carbon Steel.

Showing the number of reversals for various ranges of stress at various temperatures for a mean stress of 15 tons per sq. in.

Mean Stress. Tons per Sq. In.	No.	Maximum Tension.	Minimum Stress.	Range of Stress.	Temp. ° C.	Reversals.	Remarks.
15·06	1	−24·14	−5·98	18·16	15	1,080,000	Broke.
	2	−23·12	−7·00	16·12		38,000	,, St. 2 hours.*
	3	−24·67	−5·45	19·22		385,000	,,
	4	−22·91	−7·21	15·70		17,028,000	,, St. 3 hours.
	5	−23·05	−7·07	15·98		4,152,000	,,
	6	−22·98	−7·14	15·84		9,062,000	,,
15·00	1	−23·88	−6·12	17·76	250	1,752,000	Broke.
	2	−23·32	−6·68	16·64	252	3,211,000	,, St. 2 hours.
	3	−23·39	−6·61	16·78	253	6,641,000	,, St. 1 hour 35 min.
15·00	1	−24·65	−5·95	18·70	300	252,000	Broke.
	2	−22·81	−7·19	15·62	309	4,290,000	,, St. 1 hour 30 min.
	3	−22·84	−7·16	15·68	310	5,554,000	,,
	4	−22·73	−7·27	15·46	303	9,354,000	Not broken.
15·00	1	−22·9	−7·1	15·8	400	602,000	Broke.
	2	−22·93	−7·07	15·86	408	841,000	,,
	3	−22·25	−7·75	14·50	403	3,441,000	,, St. 10 min.
	4	−22·21	−7·79	14·42	397	6,131,000	,, St. 15 min.
15·00	1	−22·7	−7·30	15·4	503	402,000	Broke.
	2	−22·02	−7·98	14·04	505	632,000	,,
	3	−22·2	−7·8	14·4	497	1,803,000	,, St. 5 min.
	4	−22·18	−7·82	14·36	491	2,751,000	,, St. 2 min.
	5	−22·00	−8·00	14·00	496	7,243,000	Not broken.
15·00	1	−21·79	−8·28	13·48	570	302,000	Broke.
	2	−21·35	−8·65	12·70	563	387,000	,,
	3	−21·2	−8·80	12·40	575	3,612,000	,, St. 5 hours.
	4	−20·9	−9·1	11·80	570	5,710,000	,,
	5	−21·0	−9·0	12·00	569	10,873,000	,,
15·00	1	−19·16	−10·84	8·32	630	552,000	Broke.
	2	−18·75	−11·25	7·50	630	1,092,000	,, St. 2 min.
	3	−19·29	−10·71	8·58	625	1,583,000	,, St. 3 min.
	4	−18·42	−11·58	6·84	628	4,682,000	,,
	5	−18·64	−11·36	7·28	636	8,201,000	Not broken.

* St. indicates the machine was stopped for the number of hours mentioned.

TABLE IV.—K4 *Steel.*

Showing the ranges of stress for various numbers of reversals at various temperatures for equal tensions and compressions.

Stress. Tons per sq. in. + and −.	Reversals.	Temp. Deg. C.	Remarks.	No.
29·25	125,000	15	Broke	1
27·85	312,000	—	,, ...	2
27·5	877,000	—	,, ...	3
27·8	2,425,000	—	,, ...	4
27·1	4,201,000	—	,, ...	5
26·46	75,000	138	Broke	1
25·5	313,000	140	,, St. 3 min.	2
24·4	1,075,000	145	,, ...	3
23·9	1,676,000	137	,, St. 5 min.	4
23·96	5,810,000	141	,, ...	5
23·29	20,000	294	Broke	1
19·86	9,602,000	290	,, ...	2
20·63	602,000	301	,, ...	3
20·39	2,972,000	291	,, ...	4
20·01	1,790,000	542	Broke	1
19·93	6,590,000	566	Stress raised ..	2
20·46	1,668,000	566	Broke	2
19·2	2,302,000	537	,, ...	3
19·76	3,137,000	538	,, ...	4
20·1	108,000	728	Broke	1
17·76	1,241,000	724	,, ...	2
18·3	3,675,000	727	,, ...	3
22·85	38,000	729	,, ...	4
19·05	22,000	761	Broke	1
17·6	1,112,000	768	,, ...	2
18·22	425,000	775	,, ...	3
17·02	1,397,000	771	,, ...	4
17·01	3,675,000	782	,, ...	5

The results of tests on three steels are shown in Tables I to VI. As the specimens broke in nearly all cases, the safe ranges for, say, 10 million repetitions are best interpolated by plotting the usual curves showing stress against number of repetitions. These interpolated values are shown plotted in Fig. 2. Curve No. 1, Fig. 2, shows the ultimate strength of the K4 steel at various temperatures when tested statically and fracture takes place in one or two hours. Above 400 deg. C. the fracture will take place at less stress if sufficient time is allowed.

Curve 1A, Fig. 2, and Table IV show the range of stress for equal tensile and compressive stresses that this material will withstand for more than 10 million repetitions of stress. It will be seen that at temperatures as high as 760 deg. C., a range of stress of 35 tons per square inch (± 17·5 tons per square inch) is possible for more than 10 million repetitions.

Curve No. 2, Fig. 2, shows the static breaking strength for 0·14 carbon steels carried out in the ordinary way.

Curve 2A, Fig. 2, and Table I show the range of stress for equal tensile and compressive stresses for more than 10 million repetitions at various temperatures. At 400 deg. C. the strength is greater than at ordinary temperatures. Curve 3A shows the results obtained from S2 steels for equal tensile and compressive stresses.

Fig. 3 and Tables II and III and V and VI show the results obtained from the 0·14 carbon and the S2 steels for mean stresses of 10 tons and 15 tons per square inch respectively. The maximum tensile strength has been plotted against the temperature in

Fig. 1.

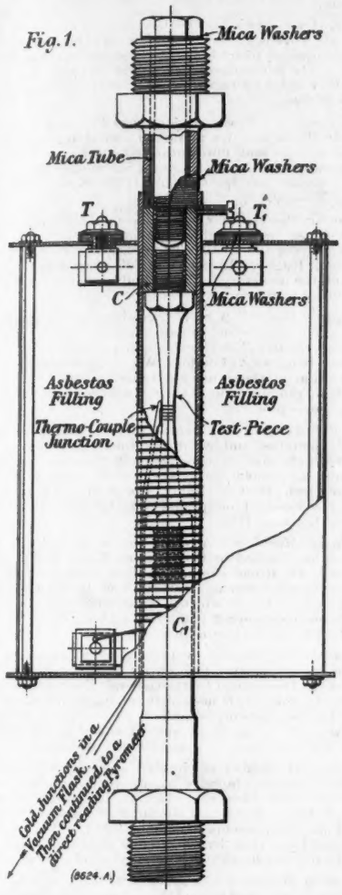


Fig. 2.

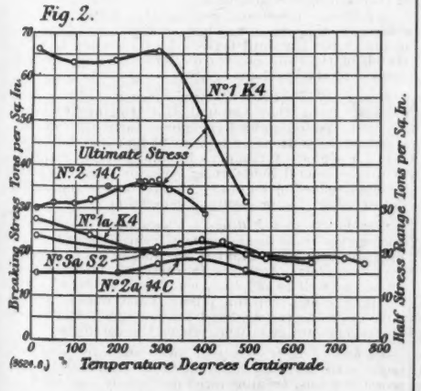


TABLE V.—S 2 STEEL.

Showing the range of stress for various numbers of reversals at various temperatures for a mean stress of 10 tons per sq. in.

Mean Stress tons per sq. in.	No.	Maximum Tension.	Minimum Stress.	Range of Stress.	Temp. ° C.	Reversals.	Remarks.
10	1	−28·41	+8·41	36·82	15	831,000	Broke.
	2	−27·89	+7·89	35·78	15	3,341,000	,,
	3	−28·08	+8·08	36·16	15	10,593,000	,,
	1	−28·09	+8·09	36·18	150	302,000	Broke.
	2	−27·91	+7·91	35·82	145	381,000	,,
	3	−27·83	+7·83	35·66	153	1,432,000	,, *St. 2 hr. 35 min.
	4	−27·9	+7·9	35·8	149	3,751,000	,, St. 10 hr.
	5	−27·63	+7·63	35·26	143	7,263,000	,, St. 1 hr. 30 min.
	6	−27·71	+7·71	35·42	152	9,732,000	,, St. 2 min. five times.
	1	−28·0	+8·0	36·8	300	1,882,000	Broke.
	2	−28·92	+8·92	37·84	308	5,743,000	,, St. 3 hr.
	3	−27·83	+7·83	35·66	302	7,763,000	,, St. 2 min. three times.
	1	−27·63	+7·63	35·26	450	1,121,000	Broke.
	2	−28·25	+8·25	36·50	445	2,723,000	,, St. 1 hr. 15 min.
	3	−27·4	+7·4	34·8	455	4,710,000	,, St. 2 hr.
	4	−27·1	+7·1	34·2	452	8,111,000	,,
	1	−28·22	+7·22	34·44	590	708,000	Broke.
	2	−27·35	+7·35	34·70	592	2,351,000	,, St. 2 min. six times.
	3	−26·71	+6·71	33·42	595	6,880,000	,, St. 2 min.
	4	−27·00	+7·00	34·00	590	11,090,000	Not broken.
	1	−25·49	+5·49	30·98	650	750,000	Broke.
	2	−25·15	+5·15	30·30	642	1,850,000	,, St. 2 min. 3 times.
	3	−24·19	+4·19	28·38	653	7,430,000	,, St. 2 min.
	4	−24·8	+4·8	29·6	650	9,746,000	,,

* St. indicates stopped in all the tables.

TABLE VI.—S 2 STEEL.

Showing the ranges of stress for various numbers of reversals at various temperatures for a mean stress of 15 tons per sq. in.

Mean Stress tons per sq. in.	No.	Maximum Tension.	Minimum Stress.	Range of Stress.	Temp. ° C.	Reversals.	Remarks.
15	1	−33·46	+3·34	36·80	15	2,128,000	Broke.
	2	−32·28	+2·16	34·44	—	8,386,000	Stress increased.
	2	−33·30	+3·18	36·48	—	1,144,000	Broke.
	3	−32·70	+2·58	35·28	—	4,334,000	,,
	4	−32·61	+2·49	35·10	—	8,002,000	,,
15	1	−31·18	+1·18	32·36	250	1,621,000	Broke.
	2	−31·3	+1·3	32·6	245	3,623,000	,, St. 3 min.
	3	−31·23	+1·23	32·46	252	9,545,000	,,
15	1	−31·45	+1·46	32·92	345	412,000	Broke.
	2	−31·06	+1·06	32·12	345	1,161,000	,, St. 10 min.
	3	−31·1	+1·1	32·2	340	6,861,000	,, St. 2 min. six times.
	4	−30·49	+0·49	30·98	348	8,631,000	,,
15	1	−30·48	+0·84	31·32	436	666,000	Broke.
	2	−29·86	−0·14	29·72	429	821,000	,, St. 12 min.
	3	−30·4	+0·49	30·98	440	2,171,000	,, St. 3 min. four times.
	4	−30·3	+0·3	30·6	438	6,292,000	,,
	5	−30·89	+0·89	31·78	439	12,640,000	Not broken.
15	1	−30·25	+0·25	30·5	470	591,000	Broke.
	2	−30·11	+0·11	30·22	482	1,852,000	Broke.
	3	−29·35	−0·65	28·70	481	4,251,000	,, St. 2 min.
	4	−30·1	+0·1	30·2	470	5,753,000	,,
15	1	−28·4	−1·6	26·8	515	661,000	Broke.
	2	−28·51	−1·49	27·02	509	1,293,000	,, St. 5 sec.
	3	−28·28	−1·72	26·56	520	4,741,000	,,
	4	−27·9	−2·1	25·8	517	6,402,000	,, St. 3 sec.
	5	−28·73	−1·27	27·46	509	8,820,000	,, St. 4 sec. six times.

Fig. 3. CURVES SHOWING MAXIMUM STRESS FOR MEAN STRESS OF 10 & 15 TONS PER SQ. IN. FOR MORE THAN 10,000,000 REPETITIONS.

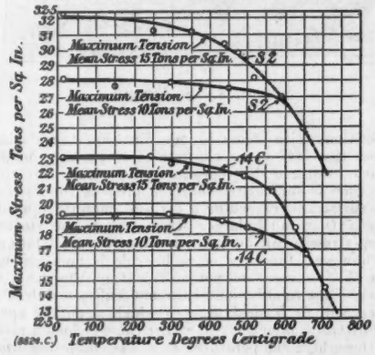
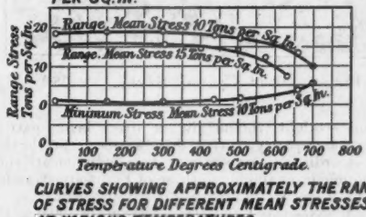
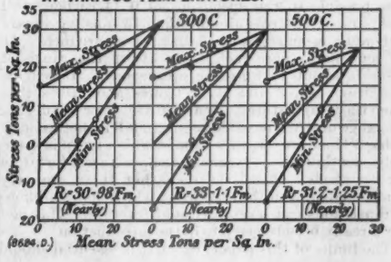


Fig. 4. CURVES FOR ·14 C STEEL.

CURVES SHOWING RANGE OF STRESS AT MEAN STRESSES OF 10 AND 15 TONS PER SQ. IN.

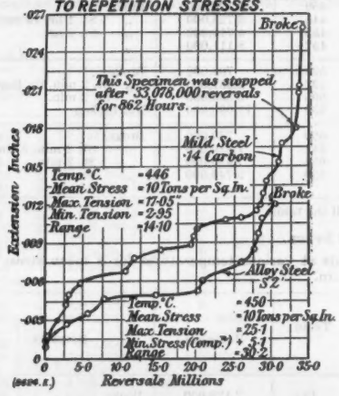

Range. Mean Stress 10 Tons per Sq. In.
Range. Mean Stress 15 Tons per Sq. In.
Minimum Stress. Mean Stress 10 Tons per Sq. In.
Range Stress Tons per Sq. In.
Temperature Degrees Centigrade.

CURVES SHOWING APPROXIMATELY THE RANGES OF STRESS FOR DIFFERENT MEAN STRESSES AT VARIOUS TEMPERATURES.



each case. The curves are practically parabolas of the form $f = F - k\,T^2$ where T is the absolute temperature and F the range at absolute zero. When f is zero, T should be the melting-point of the steel or the stress at which the steel becomes sufficiently fluid to have very small viscosity. The mean stress corresponding to each curve can be obtained from the tables. In Fig. 4 the range of stress for 0·14 carbon steel at various temperatures is shown, also three curves for temperatures of 150 deg. C., 300 deg. C., and 500 deg. C. are plotted, showing the range of stress for various mean stresses. Only three mean stresses are plotted, but it will be seen that the curves of maximum and minimum stresses are approximately straight lines, but only approximately. The equations for range of stress in terms of the mean stresses are given in the figure. The authors have shown that at ordinary temperatures for 0·14 carbon steel the curves

Fig. 5. CURVES SHOWING CREEP OF METALS IN THE HAIGH MACHINE SUBJECTED TO REPETITION STRESSES.


Broke
This Specimen was stopped after 33,078,000 reversals for 862 Hours.
Mild Steel ·14 Carbon
Temp. °C. = 446
Mean Stress = 10 Tons per Sq. In.
Max. Tension = 17·05
Min. Tension = 2·95
Range = 14·10
Broke
Alloy Steel S 2
Temp. °C. = 450
Mean Stress = 10 Tons per Sq. In.
Max. Tension = 25·1
Min. Stress (Comp.) = 5·2
Range = 30·2
Extension Inches
Reversals Millions
(scale.s.)

not be exceeded, have made it possible to refer only to a few steels and to a few of the many interesting points that arise from a consideration of these experiments. Other steels have been tested and much other information on the statical and repetitive properties of metals at various temperatures has been obtained and are being further investigated. Both the repetition work and the statical work are very laborious. It may be that for an infinite number of

TABLE VII.

	Per square inch.
350 deg. C.	28 tons.
400 „ C.	14 „
500 „ C.	4 „

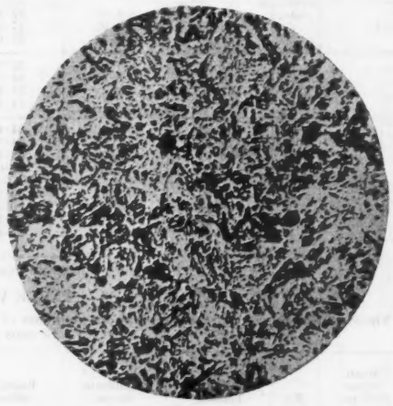


FIG. 7. K_4 STEEL. × 300.

FIG. 6. 0·14 CARBON STEEL. × 380.

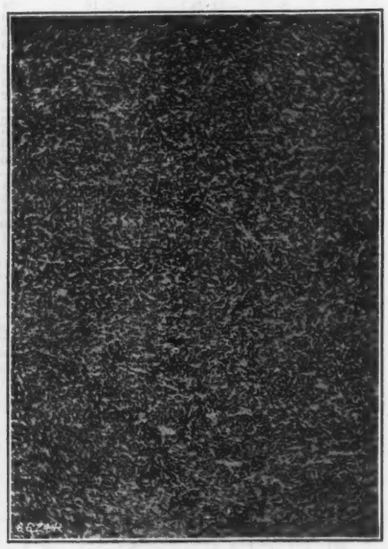


FIG. 8. S_2 STEEL.

are not straight, the maximum stress being partly concave and partly convex downwards. For the S_2 steel at ordinary temperatures maximum mean and minimum curves similar to those of Fig. 4 are straight lines.

It will be seen that up to temperatures of 500 deg. C. it is possible to run specimens of 0·14 carbon steel with a range of stress of more than 13 tons per square inch and a mean stress of 15 tons per square inch. At 10 tons per square inch mean stress the range of stress is about 14 tons per square inch. It will be seen from Fig. 3 and other figures and tables that when the temperature exceeds 500 deg. C. or 600 deg. C. the range of stress possible begins to fall rather rapidly. Table VII shows the stress above which creep is statically continuous at various temperatures for 0·14 carbon steels. It will be seen that these are very much smaller than the stresses at which many millions of repetitions can be run without fracture. This fact has already been referred to in the introduction.

The limits of this paper, which it is essential should repetitions with stress in one direction the statical stress that will cause continuous creep may be the limiting range under repetition stress, but, providing the time is sufficiently short to prevent the viscous slip (or strain) exceeding a certain amount, it would appear that much larger stresses than the statical creep stresses can be applied without risk of failure. If, however, the time of each cycle is long enough and the temperature not sufficient in this time to allow of the re-adhesion of the molecules, a molecular creep will be formed near to which a pulling-apart failure can commence. Whether there is such a thing at these high temperatures as a real endurance limit will have to be investigated, but what is possible at the present time is to fix for certain mean stresses and certain ranges of stress the life of the specimen. For the present, therefore, the safest procedure will be to define the stress range which the material at a certain temperature will resist for a specified number of repetitions. The micro-photographs of the three steels show that the structures are normal.

CATALOGUES.

Railway Axle-boxes.—Messrs. Hyatt, Limited, 58, Victoria-street, London, S.W.1, have sent us two leaf catalogues showing the design of their self-aligning axle-boxes for railway rolling stock of light and heavy types.

Electrical Circuit Breakers.—Mr. George Ellison, Perry Barr, Birmingham, has issued a little eight-page pamphlet, explaining in simple terms the cases and circumstances in which circuit breakers should be used instead of relying on fuses.

Motor-Cycle Chains.—The Coventry Chain Company, Limited, Coventry, have issued a little booklet stating which chains of their standard range are used on motor-cycles. The particulars given are the chain list numbers and the number of teeth for front drive, rear drive and magneto drive.

Oil Engines.—Messrs. Ruston and Hornsby, Limited, Lincoln, have issued a pamphlet containing a long list of the vertical and horizontal cold-starting oil engines supplied by them, and also giving full reports of separate tests carried out by Captain H. R. Sankey and Mr. W. A. Tookey.

Electric Motors.—A new edition of their catalogue of single-phase and polyphase induction motors has come to hand from the British Thomson-Houston Company, Limited, Rugby. It contains full descriptive matter with all the necessary technical and commercial information in tabular form.

Electric Motors.—A revised edition of their catalogue of asynchronous-synchronous motors has been issued by the English Electric Company, Limited, Queen's House, Kingsway, London, W.C.2, containing a full description of these machines and a list of about 30 supplied, ranging from 143 brake horse-power to 1,200 brake horse-power.

Water Towers.—Diagrams, tables and notes from which sketches and estimates may be made of the approximate cost of concrete water towers of 10,000 gallons to 500,000 gallons capacity, and of heights ranging from 10 ft. to 100 ft., are given in a catalogue issued by Messrs. Trollope and Colls, Limited, 5, Coleman-street, London, E.C.

Mining Machines.—A recent issue of M. & C. Machine Mining has reached us from Messrs. Mavor and Coulson, Limited, 47, Broad-street, Mile End, Glasgow. It contains much interesting matter about their coal-cutting machines, the use of which is extending, and also about mechanical conveying plant for carrying the coal from the face to the tub tram lines.

Telephones, &c.—A very complete catalogue of telephone apparatus, fire alarms and water-level indicators has been issued by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2. The full equipments supplied are designed to allow additions to be made at any time without interfering with the operation of those already installed.

Fans.—A number of circulars specially addressed to colliery owners, laundry proprietors, woollen manufacturers, hop driers and blacksmiths have been issued by the James Keith and Blackman Company, Limited, 27, Farringdon-avenue, London, E.C.4. We have also received from this firm a circular dealing with a small enclosed water-heating boiler, burning coke or anthracite.

Testing Machines.—Messrs. Alfred J. Amsler and Co., of Schaffhouse, Switzerland, have prepared a new edition of their abridged catalogue of materials, testing machines and precision measuring instruments, containing particulars relating to some new designs and improvements in the standard types. An interesting historical sketch of the firm, now in its 70th year, appears as a preface to the catalogue.

Heavy Oil Engines.—A new catalogue of heavy oil engines, from the National Gas Engine Company, Limited, Ashton-under-Lyne gives particulars of eight standard sizes from 18-h.p. to 83-h.p. and four twin-cylinder engines of 92-h.p. to 166-h.p. These engines are of the horizontal self-starting type, and consume crude, residual, refined or tar oils. All sizes are made for both industrial driving or electrical generation.

Gas Valves and Fittings.—A catalogue of gas valves and accessory fittings received from Messrs. J. Blakeborough and Sons, Limited, Brighouse, Yorks, shows a very full range of valves in cast-iron, gun-metal and bronze as well as of pipes, couplings, bends, etc., tools for pipe laying, capstan pillars, hand wheels, syphon, boxes, and the various hand and manhole street fittings. Dimensions are given throughout the catalogue.

Turbo-Generators.—Several turbo-generator sets, complete with auxiliary machinery, as installed in large power stations, are illustrated and briefly described in a catalogue received from the Metropolitan Vickers Electrical Company, Limited, Trafford-park, Manchester. The examples shown include sets for the Glasgow, Salford, Liverpool, and Manchester Corporations, the Metropolitan Railway Company, and the Clyde Valley Electric Power Company.

Electric Furnaces.—A furnace with internal electric heaters, suitable for heat treatment and general industrial purposes requiring temperatures up to 1,000 deg. C., is illustrated in a catalogue received from Automatic and Electric Furnaces, Limited, 173, Farringdon-road, London, E.C.1. These furnaces are built on a unit system which enables the firm to supply any size required with heaters to suit the work. It is stated in the catalogue that the costs of heat are equal when town gas is 2s. 10d. per 1,000 cub. ft. and electricity 1d. per unit.